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Introduction

About This Book

This book supplies an introduction to the 777 airplane systems. This book uses a basic airplane configuration, but it has data on some usual options. The description of the systems includes:

- Component location
- Component installation
- System operation.

To get more system data, refer to other Boeing publications such as the Airplane Flight Manual, Operations Manual, Airplane Maintenance Manual, and Detail Specification. If the data in this book does not agree with the data in these publications, use the publications.

This book shows the design of the airplane as of the date of printing. It is for training purposes only.

Features

The 777 design is for ETOPS (extended range operation with two-engine airplanes).

The 777 has an advanced flight compartment for two crew operation. It has digital avionics and flat panel liquid crystal displays.

An airplane information management system (AIMS) supplies these functions:

- Primary display functions
- Flight management computing functions
- Data conversion gateway functions
- Central maintenance functions
- Communications management
- Airplane condition monitoring
- Flight data acquisition
- Thrust management functions.

Other features include:

- Fly-by-wire technology
- ARINC 629 data buses
- Ultrasonic fuel quantity measurement
- Six-wheel landing gear trucks with steering
- An air data inertial reference system (ADIRS)
- A cabin services system
- An electrical load management system (ELMS)
- Composite structures.

- **Principal Characteristics**
- **Payload Capabilities**
- **Ground Operations**

	777 - 200	777 - 200ER	777 - 200LR	777 - 300	777 - 300ER
Maximum Weight, Lb (Kg) Taxi Takeoff Landing Zero Fuel	 537,000 (243,600) 535,000 (242,700) 445,000 (201,900) 420,000 (190,500)	 634,500 (287,800) 632,500 (286,900) 460,000 (208,700) 430,000 (195,000)	 750,000(340,194) 752,000(341,101) 487,000(221,363) 456,000(207,272)	 662,000 (300,300) 660,000 (299,400) 524,000 (237,700) 495,000 (224,500)	 752,000 (341,101) 750,000 (340,194) 554,000 (251,290) 524,000 (237,682)
Engines Thrust, Lb Pratt & Whitney General Electric Rolls Royce	 74,600 - 77,200 76,400 - 90,000 73,400 - 76,900	 84,600 - 90,600 90,000 - 94,000 84,900 - 92,000	 N/A 110,000 N/A	 98,000 N/A 95,000	 N/A 115,000 N/A
Fuel Capacity U.S. Gal (L)	31,000 (117,300)	45,220 (171,200)	53,440(202,000)	45,220 (171,200)	47,890 (181,300)
Seating Three Class Two Class All Economy (10 Abreast)	 305 375 440	 305 375 440	 301 375 440	 368 451 550	 365 451 550
Lower Hold Volume Cubic Feet (Cubic Meters)	5,656 (160)	5,656 (160)	5,302(150)	7,552 (214)	7,080 (200.5)
Maximum Operating Speed Knots CAS (Mach)	330 (0.87)				

Principal Characteristics

Principal Characteristics

The 777 is a twin-engine airplane. It is for medium and long range flights. The 777 size is between a 767-300 and a 747-400.

Boeing has these four 777 airplanes:

- 777-200 (4000 to 5000 miles)
- 777-200ER (6000 to 7000 miles)
- 777-300 (777-200ER stretched)
- 777-300ER (6000 to 7000 miles).

A fifth version of the 777 will go into service. This airplane is the:

- 777-200LR (9,000 miles).

Not all data on the 777-200LR is in this document.

Payload Capabilities

Seat combinations include:

- Six-abreast first class
- Seven or eight-abreast business class
- Nine or ten-abreast economy class.

The 777 gives better passenger comfort and appeal with a new entertainment system and flexible cabin configuration.

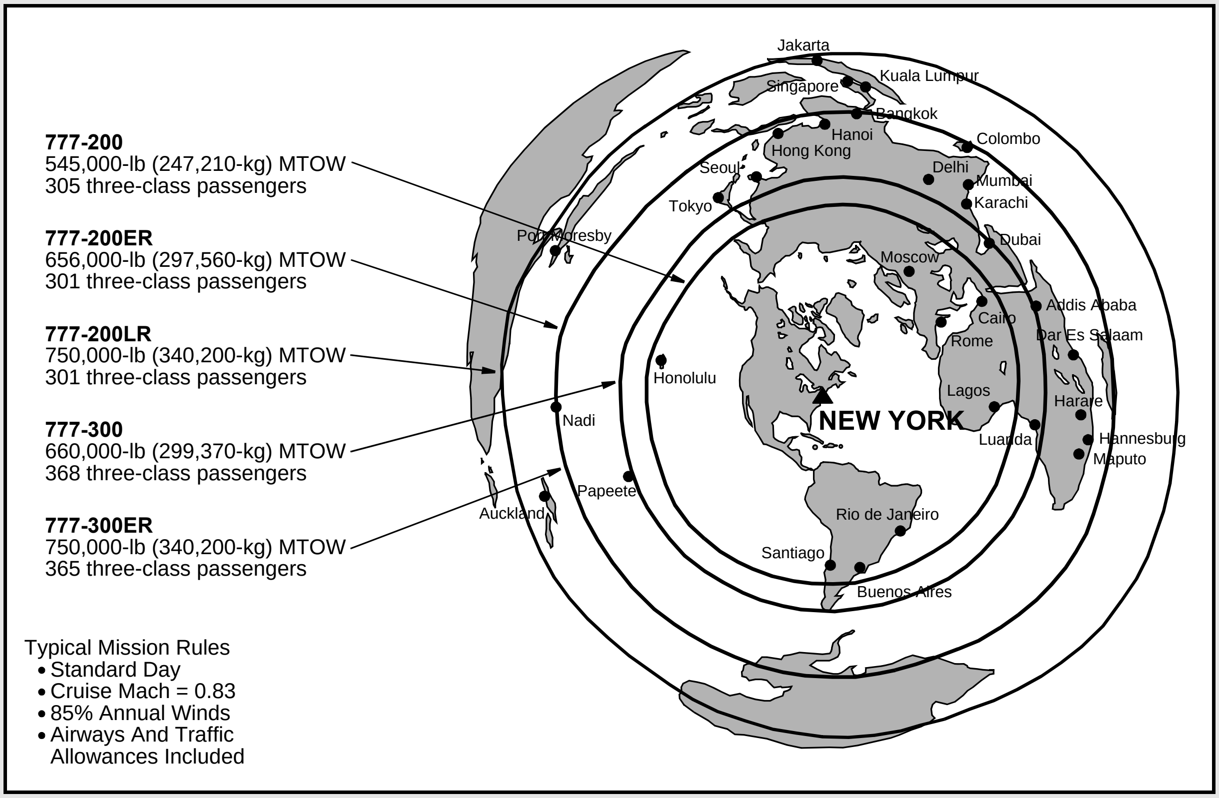
New overhead flight and cabin crew rest areas increase passenger cabin revenue capability.

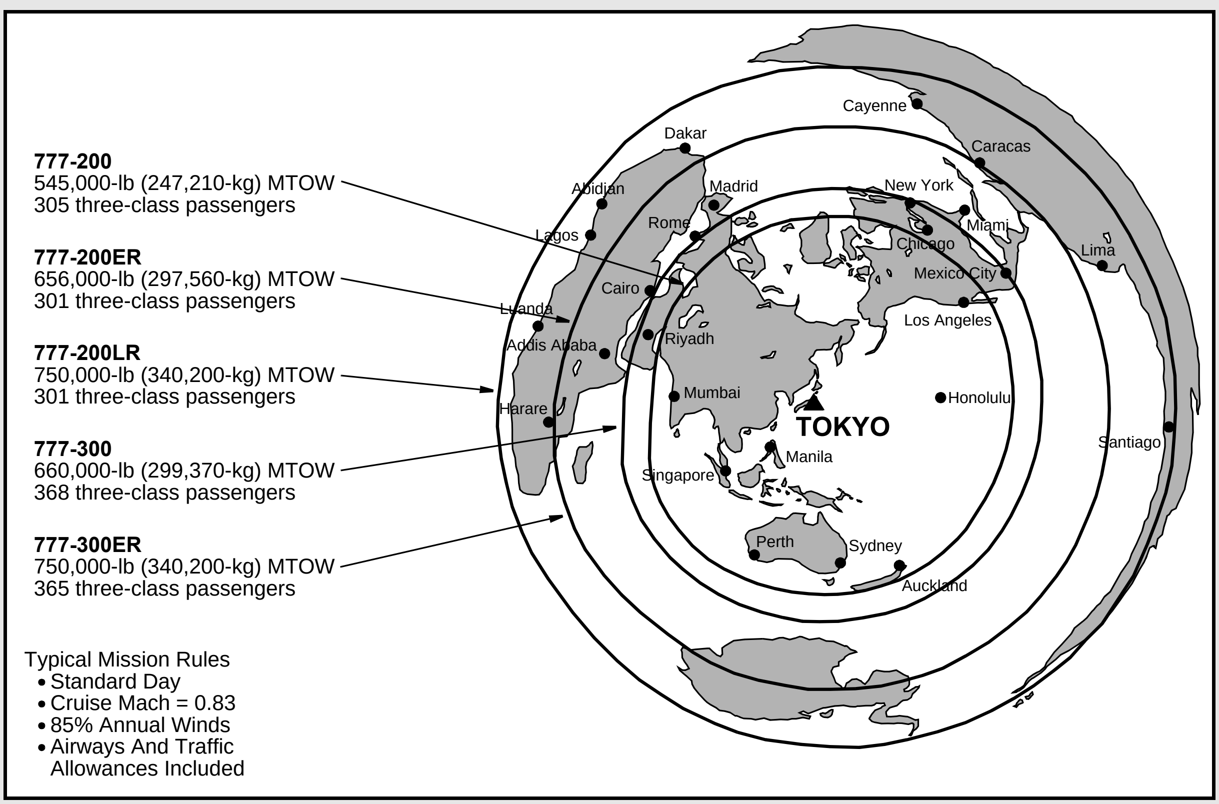
Ground Operations

Doors, service connections, and access panels give easy access. It is possible to do servicing of these locations at the same time. This decreases turnaround times.

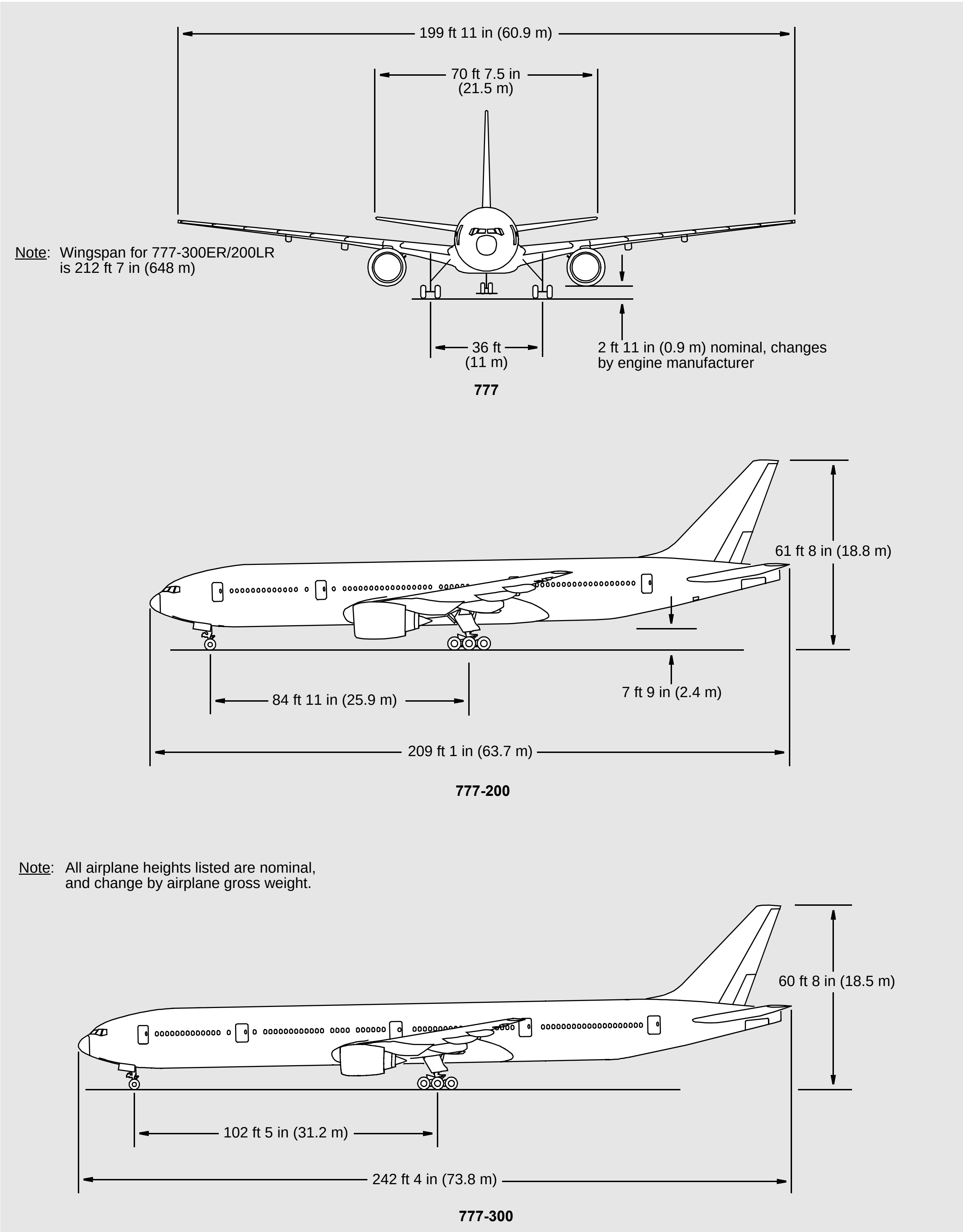
The central maintenance computing function (CMCF) of the airplane information management system (AIMS) collects fault data and supplies a central location for access to maintenance data and system test. This decreases turnaround times.

A power-operated cargo system decreases load and unload times.

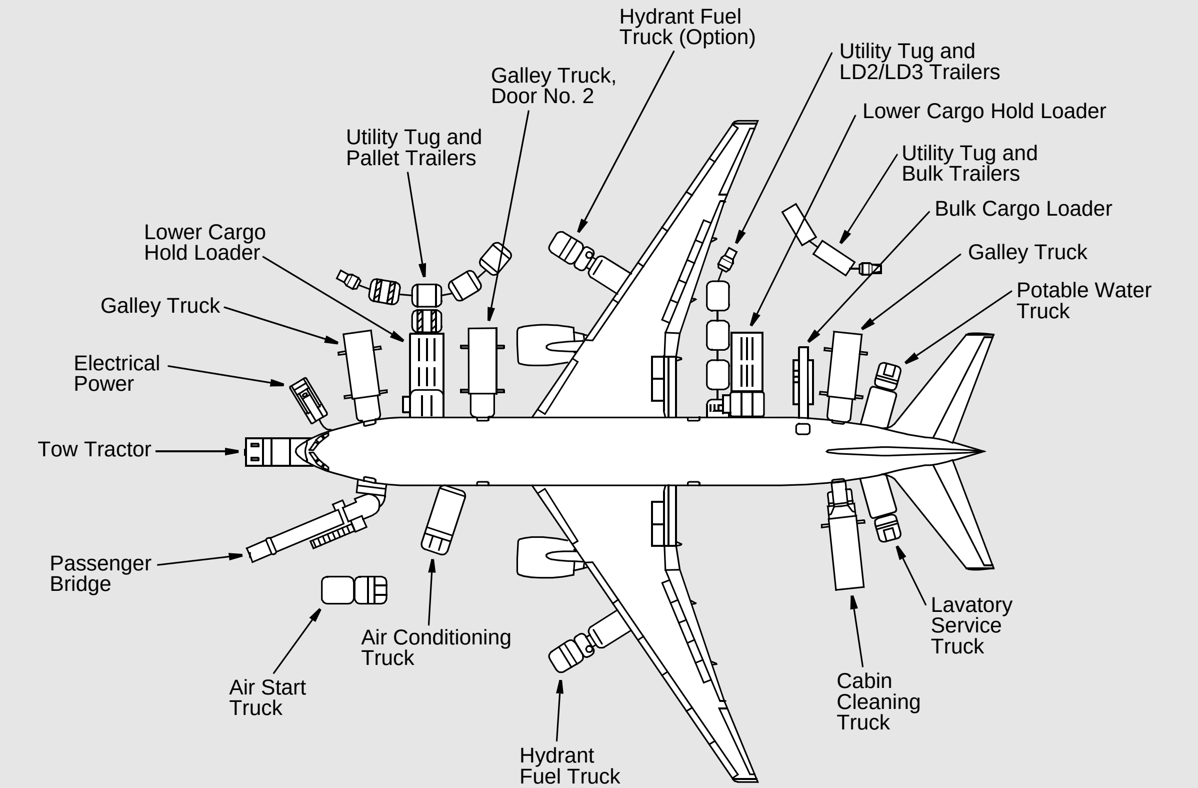




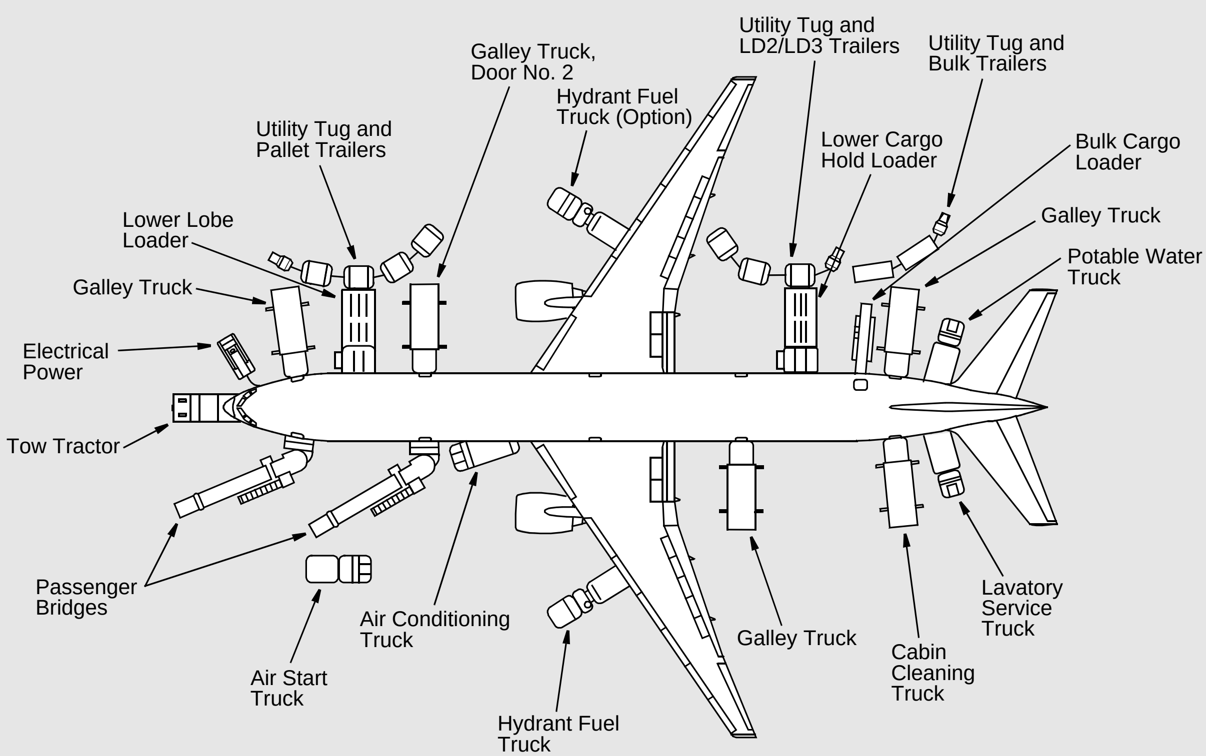
Range Capability



777 Dimensions



777 - 200



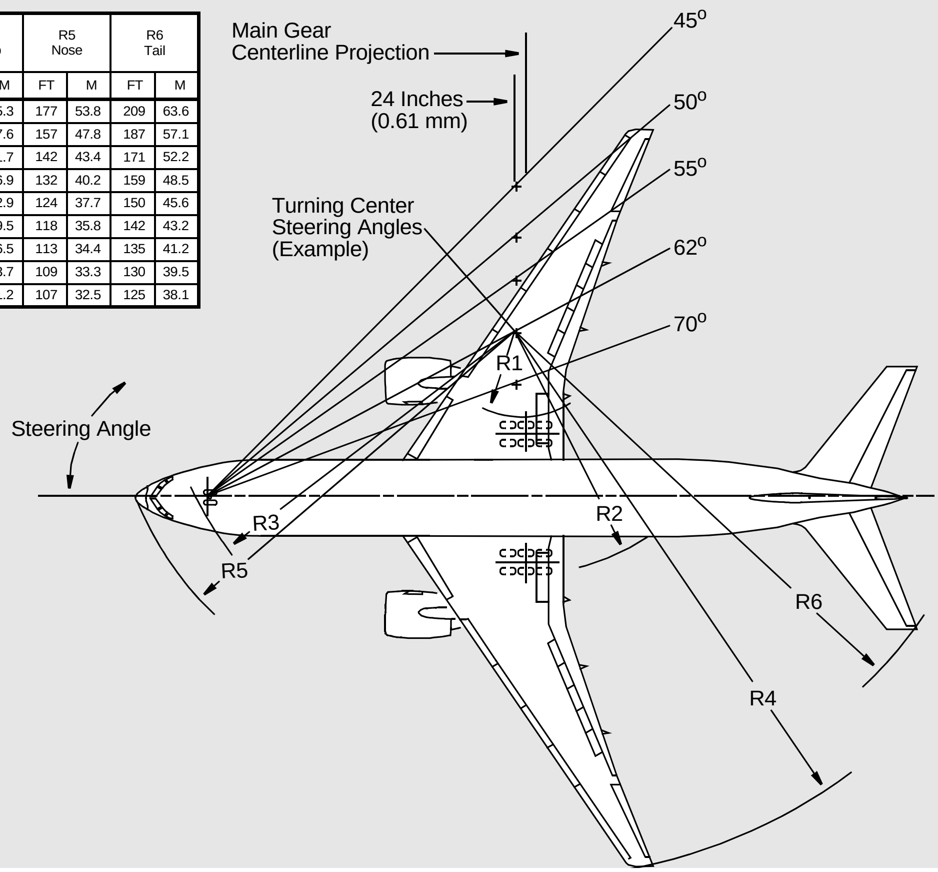
777 - 300

Ground Operations

Steering Angle (Deg)	R1 Inner Gear		R2 Outer Gear		R3 Nose Gear		R4 Wingtip		R5 Nose		R6 Tail	
	FT	M	FT	M	FT	M	FT	M	FT	M	FT	M
30	123	37.5	165	50.3	168	51.3	247	75.3	177	53.8	209	63.6
35	98	29.7	140	42.6	147	44.8	222	67.6	157	47.8	187	57.1
40	78	23.7	120	36.6	131	40.0	202	61.7	142	43.4	171	52.2
45	62	18.9	104	31.7	120	36.4	187	56.9	132	40.2	159	48.5
50	49	14.8	91	27.7	111	33.7	174	52.9	124	37.7	150	45.6
55	37	11.2	79	24.1	103	31.5	162	49.5	118	35.8	142	43.2
60	27	8.1	69	21.0	98	29.9	152	46.5	113	34.4	135	41.2
65	17	5.3	60	18.2	94	28.6	143	43.7	109	33.3	130	39.5
70 (Max)	9	2.7	51	15.6	90	27.6	135	41.2	107	32.5	125	38.1

Notes: Actual turn radii can be more than shown.
Dimensions are to nearest foot and 0.1 meter.

R4 radius inreased 6 feet (2M) for 777-200LR

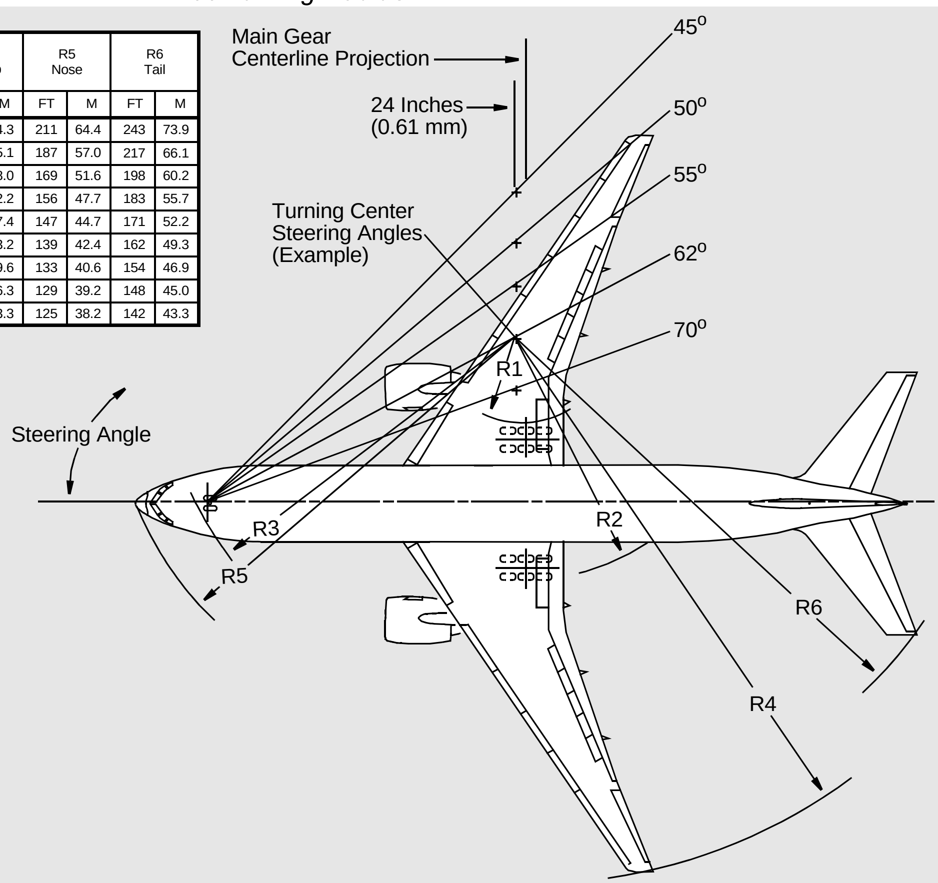


777-200 Turning Radius

Steering Angle (Deg)	R1 Inner Gear		R2 Outer Gear		R3 Nose Gear		R4 Wingtip		R5 Nose		R6 Tail	
	FT	M	FT	M	FT	M	FT	M	FT	M	FT	M
30	153	46.5	196	59.6	202	61.7	277	84.3	211	64.4	243	73.9
35	122	37.2	165	50.3	177	53.9	247	75.1	187	57.0	217	66.1
40	98	30.0	141	43.1	158	48.1	223	68.0	169	51.6	198	60.2
45	79	24.1	122	37.2	144	43.8	204	62.2	156	47.7	183	55.7
50	63	19.2	106	32.3	133	40.4	188	57.4	147	44.7	171	52.2
55	49	14.9	92	28.0	124	37.8	175	53.2	139	42.4	162	49.3
60	37	11.1	80	24.2	118	35.8	163	49.6	133	40.6	154	46.9
65	25	7.8	68	20.8	112	34.3	152	46.3	129	39.2	148	45.0
70 (Max)	15	4.6	58	17.7	108	33.1	142	43.3	125	38.2	142	43.3

Notes: Actual turn radii can be more than shown.
Dimensions are to nearest foot and 0.1 meter.

R4 radius inreased 6 feet (2M) for 777-300ER



777-300 Turning Radius

Features

STRUCTURAL DESIGN

The design of the fail-safe structure includes:

- Relevant experience from the Boeing aging fleet program
- Redundant structural load paths
- Fatigue tests.

A plan for scheduled structural inspections and coordination with the airlines completes the design process.

COMPOSITE MATERIAL USAGE

The use of new composite materials on the 777 helps:

- Improve resistance to damage
- Prevent corrosion
- Reduce overall airplane weight.

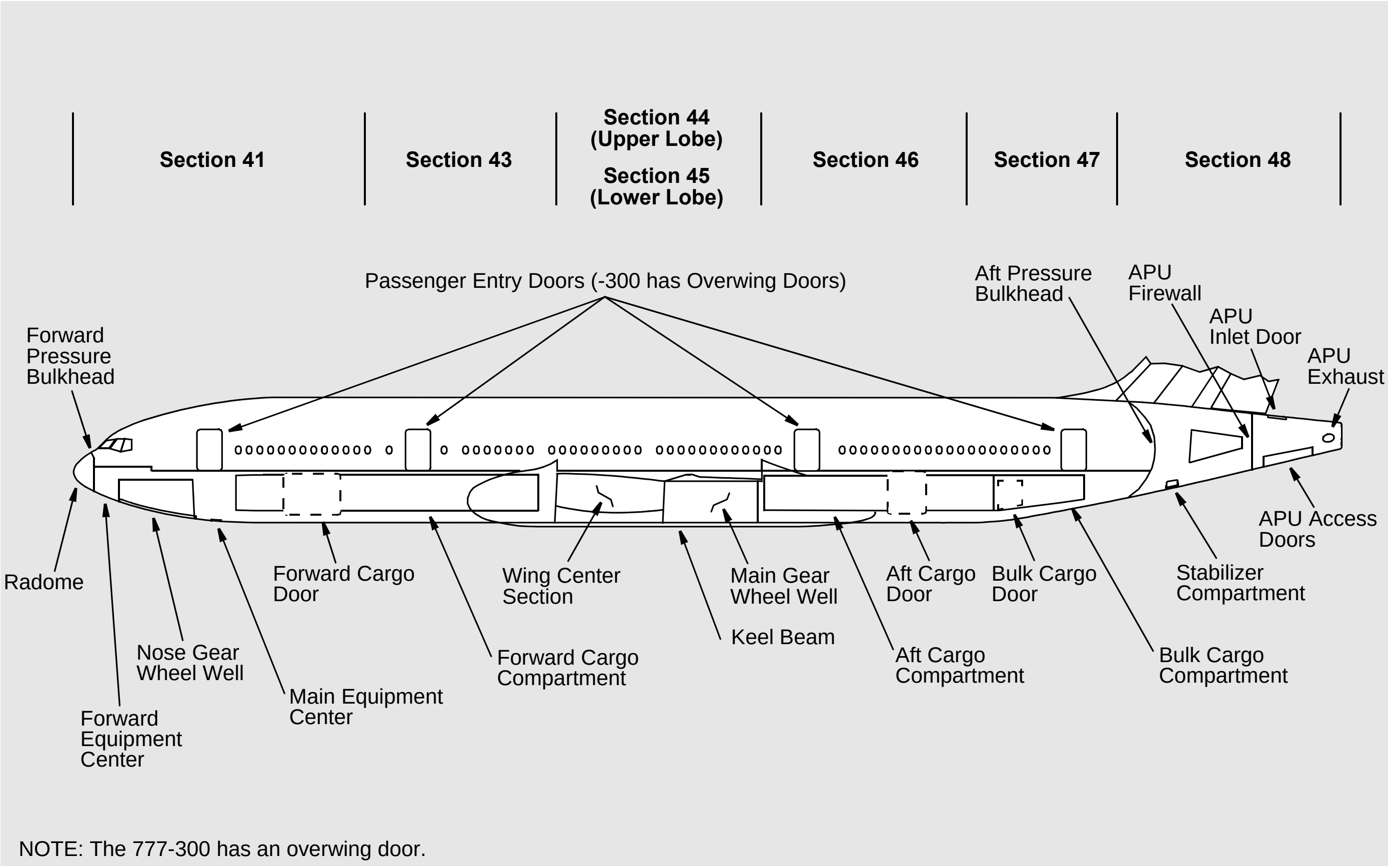
CORROSION PROTECTION

The corrosion protection for the 777 includes:

- Better drainage
- Increased use of corrosion resistant materials
- Special protective coatings and sealants.

Corrosion prevention procedures are continuously updated for the latest technology and in-service experience. This helps to keep a structurally-durable airplane.

- **Fuselage**
- **Wing**
- **Composite Structure**
- **Stabilizers**
- **Corrosion Prevention**



Fuselage

Fuselage

The fuselage is a pressurized semi-monocoque structure. It is made with circumferential frames, longitudinal stringers, stressed skin, and pressure bulkheads.

The fuselage includes many improvements that were identified by the Boeing aging fleet program.

FUSELAGE SECTIONS

These are the major fuselage sections and their station numbers (STA).

Section 41 (STA 92.5 - 655). This section contains these items:

- Radome
- Flight deck
- Forward pressure bulkhead
- Forward equipment center
- Nose gear wheel well
- Main equipment center
- Forward cargo door (right side)
- Forward part of the forward cargo compartment.

Section 43 (STA 655 - 1035). This section contains the aft part of the forward cargo compartment

Section 44/45 (STA1035 - 1434). This is the center portion of the fuselage. It contains these items:

- Wing center section
- Keel beam
- Main gear wheel wells.

Section 46 (STA 1434 - 1832). This section contains these items:

- Aft cargo door (right side)
- Aft cargo compartment.

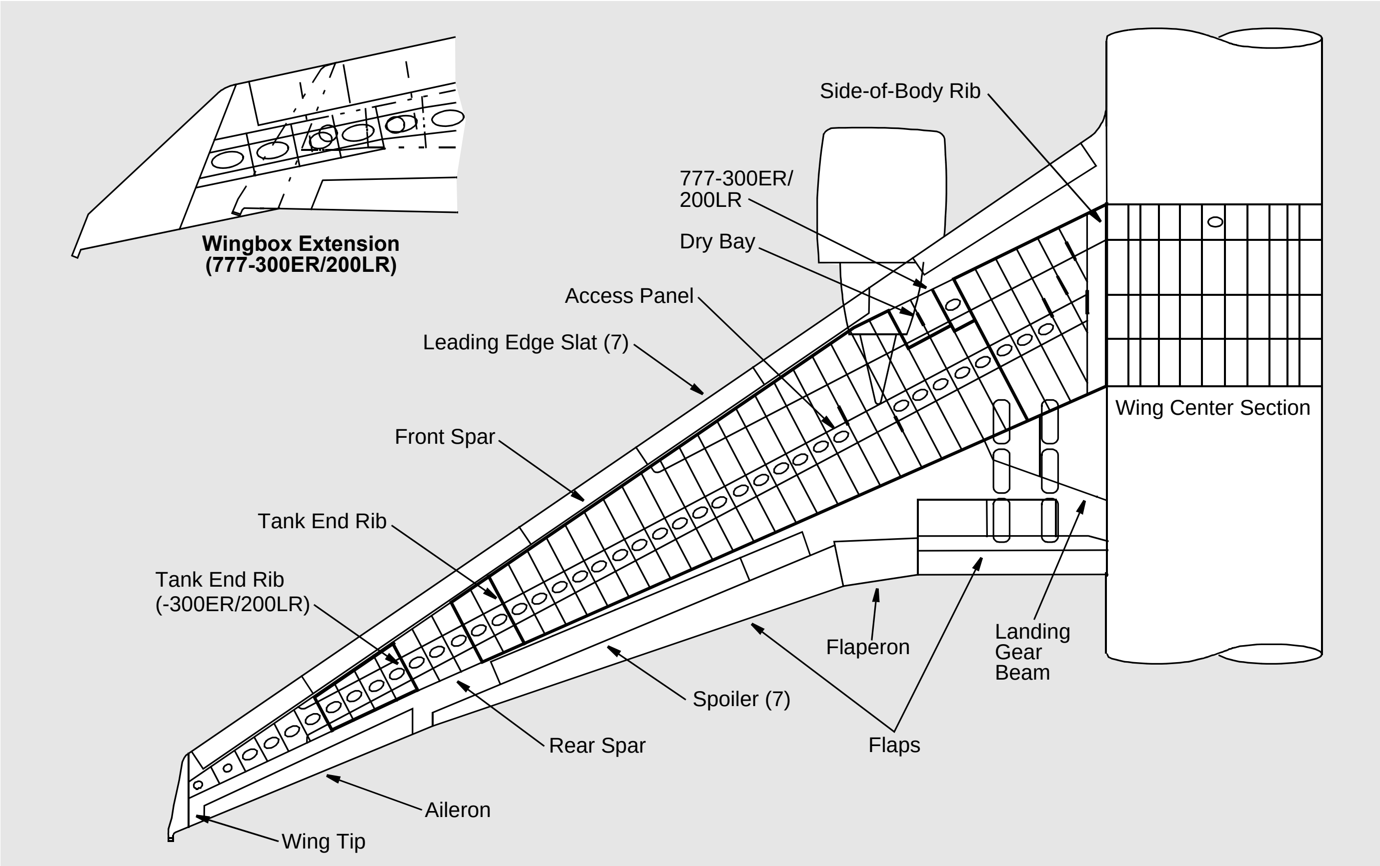
Section 47 (STA 1832 - 2150). This section contains these items:

- Bulk cargo door (right side)
- Bulk cargo compartment.

Section 48 (STA 2150 - 2570). This section contains these items:

- Aft pressure bulkhead
- Stabilizer compartment
- APU firewall
- APU inlet and exhaust
- APU compartment.

All sections except sections 45 and 48 contain parts of the passenger compartment.



Wing

Wing

The wing holds fuel, contains fuel system components, and includes the attachment points for the engine strut, landing gear, and flight control surfaces.

WING PRIMARY STRUCTURE

The wing primary structure is aluminum alloy and includes:

- Front and rear spars
- Skin panels
- Stringers
- Ribs.

Tank end ribs are sealed and make the ends of the fuel tanks. The side-of-body rib connects the outboard wing section to the wing center section.

The main landing gear attaches to the wing rear spar and the landing gear beam.

WING SECONDARY STRUCTURE

The wing secondary structure includes the leading edge, trailing edge, and aerodynamic fairings. The leading edge slats attach to the front spar. These items attach to the rear spar and auxiliary structure:

- Trailing edge flaps
- Aileron
- Flaperon
- Spoilers.

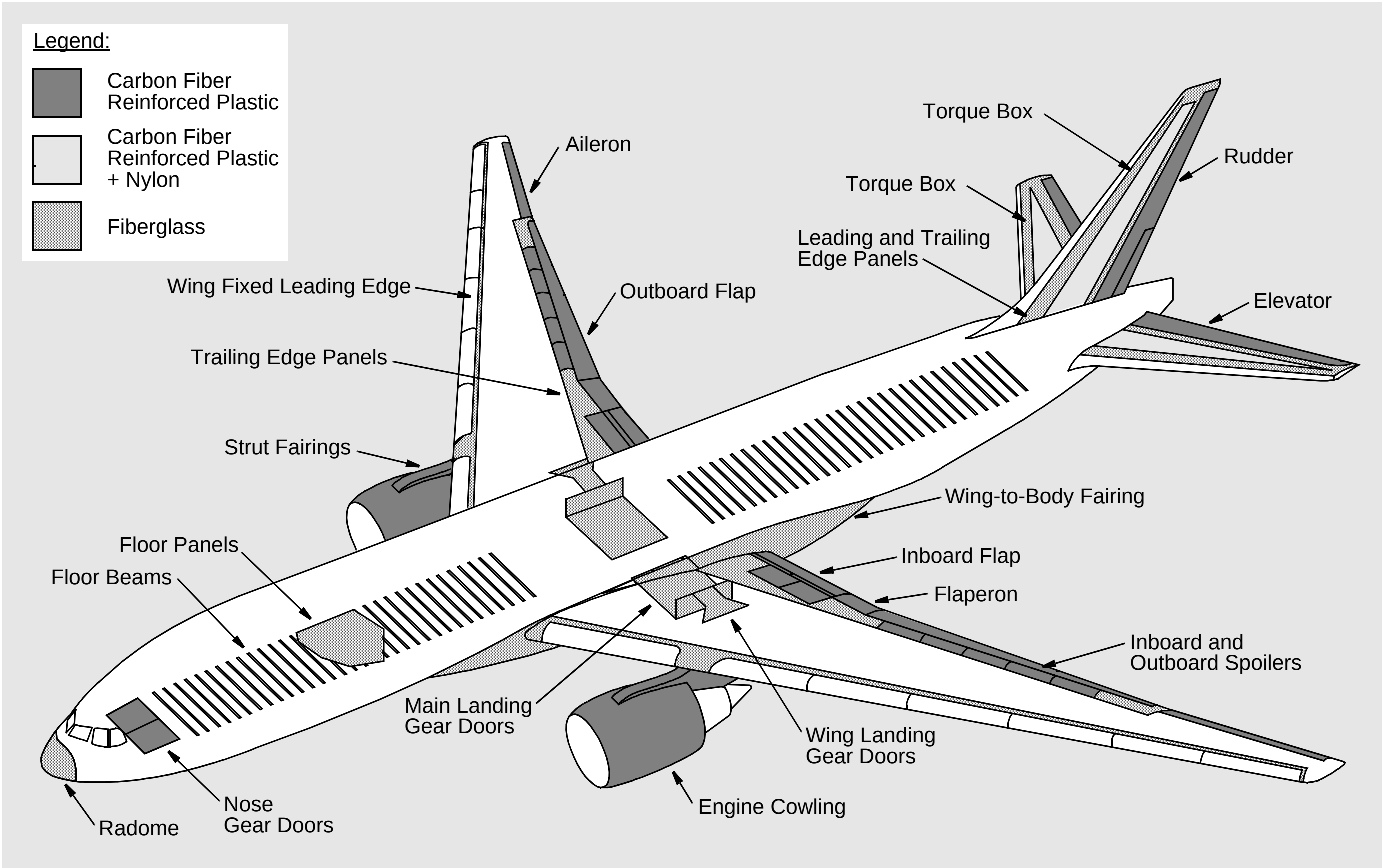
The wing tip is an aerodynamic fairing on the end of the wing.

WING ACCESS PANELS

Access panels are on the lower surface of the wing. The wing center section has one access panel. Openings in some ribs and the center section spanwise beams permit movement in the tank.

CHANGES FOR 777-300ER/200LR

The 777-300ER and 777-200LR have an extended wing and new wingtip. Fuel tank volume increases with a new tank end rib. Center tank volume also increases into part of the wing dry bay.



Composite Structure

Composite

Some of the airplane structure is made of composite materials to improve resistance to corrosion and to reduce weight.

Composite materials are layers or plies of high strength fibers (carbon fiber or fiberglass) in a mixture of plastic resin. Components made of composite materials use laminations or combine layers of the composite materials with a honeycomb core to form a sandwich construction.

The structural repair manual contains the necessary inspections, damage limits, and repair procedures for each component.

CARBON FIBER REINFORCED PLASTIC

These structural components are made of carbon fiber reinforced plastic:

- Elevators
- Rudder
- Ailerons
- Flaperons
- Flaps
- Spoilers
- Strut fairings
- Engine cowlings
- Nose gear doors.

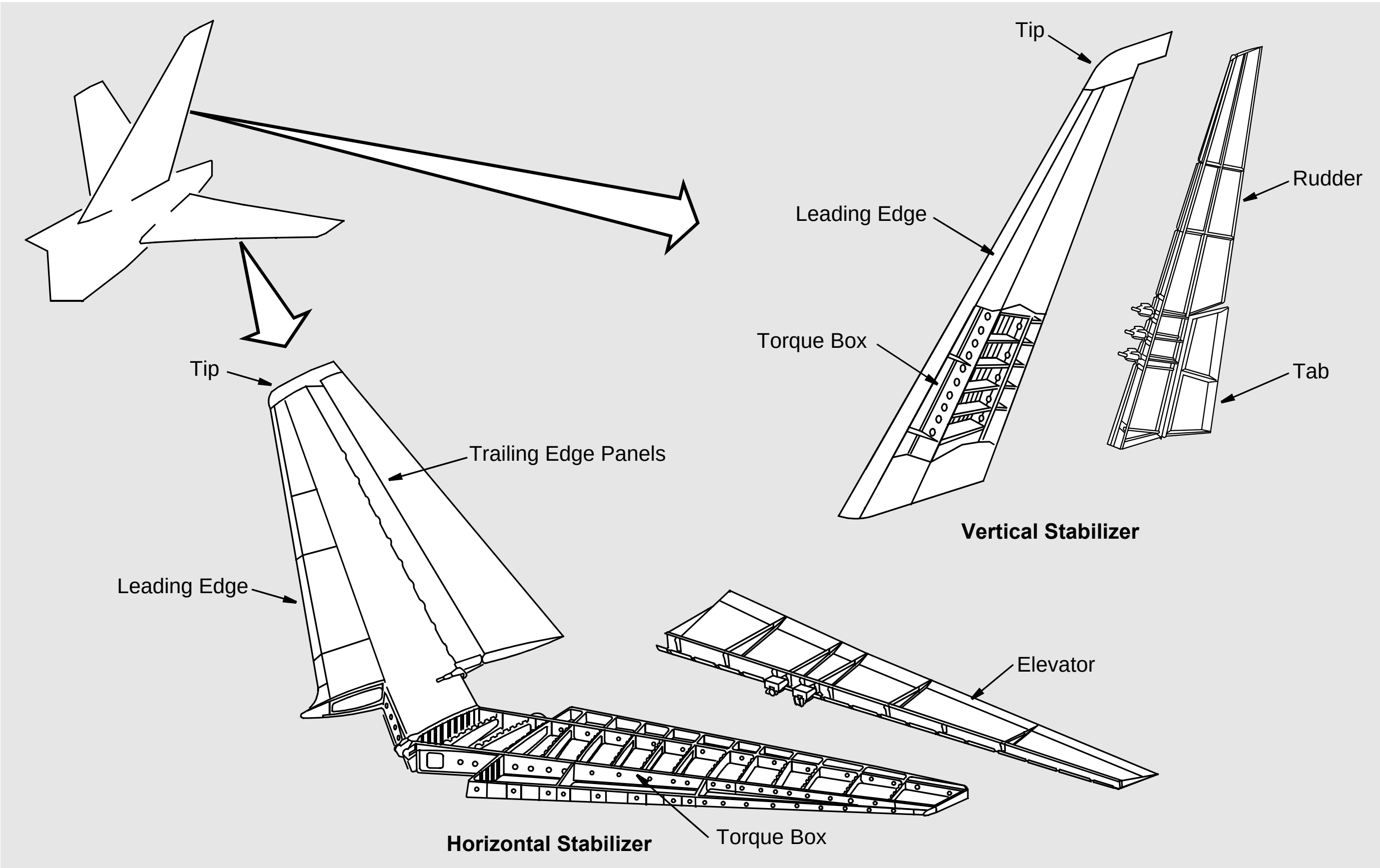
These structural components are made of carbon fiber reinforced plastic + nylon (toughened carbon fiber reinforced plastic):

- Torque boxes
- Floor beams.

FIBERGLASS

These structural components are made of fiberglass:

- Leading and trailing edge panels
- Wing-to-body fairing
- Wing and main landing gear doors
- Floor panels
- Radome.



Stabilizers

Stabilizers

Major structural parts of the stabilizers are made of composite materials.

HORIZONTAL STABILIZER

These components of the horizontal stabilizer are made of toughened carbon fiber reinforced plastic:

- Torque box spars
- Ribs
- Stringers
- Skins.

The elevators are made of carbon fiber reinforced plastic.

VERTICAL STABILIZER

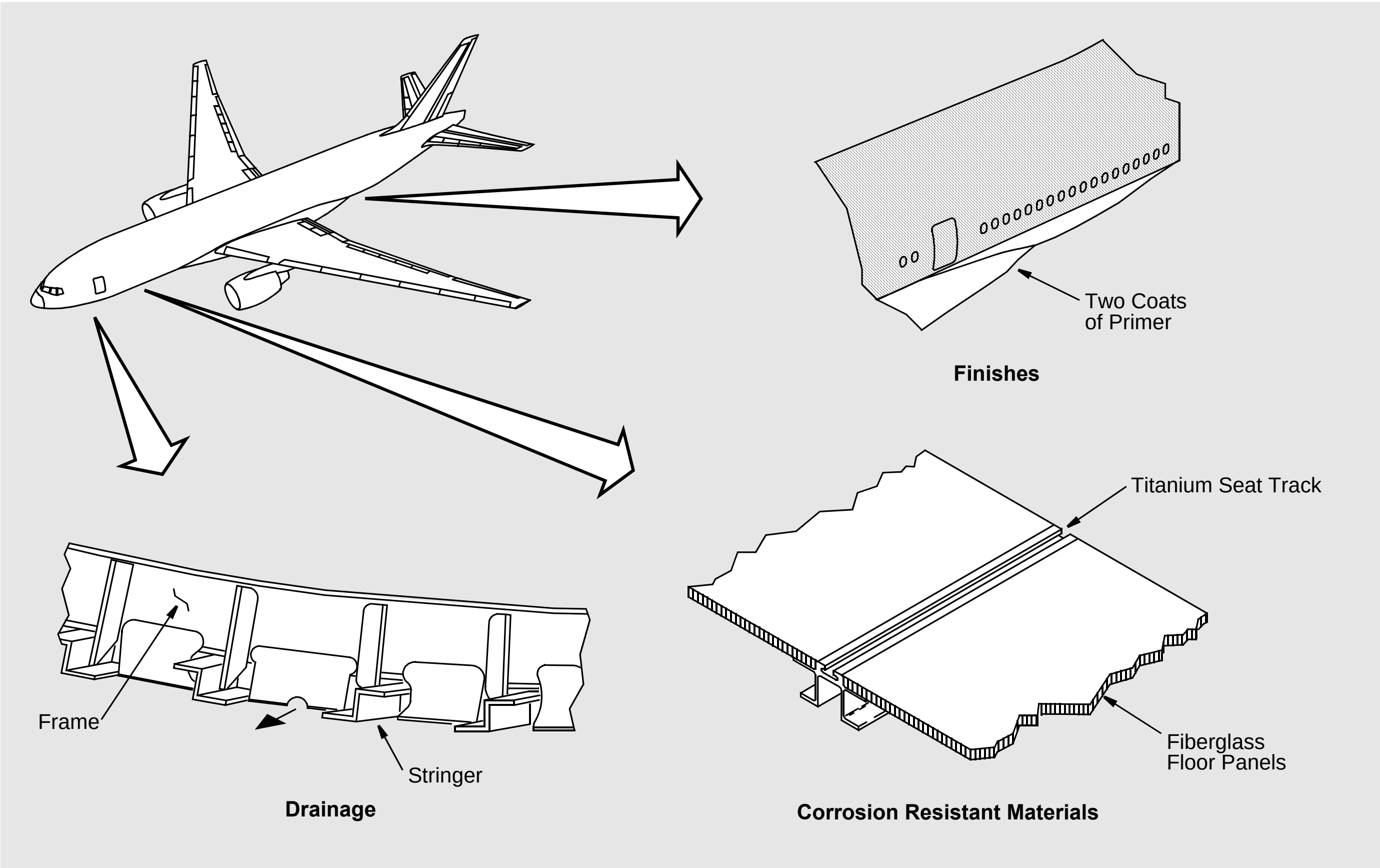
These components of the vertical stabilizer are made of toughened carbon fiber reinforced plastic:

- Torque box spars
- Ribs
- Stringers
- Skins.

Auxiliary structure is aluminum or titanium. The leading edge and tip are removable. All panels are fiberglass.

Only the panels on the left side of the stabilizer are removable for access.

The rudder and tab structure are made of carbon fiber reinforced plastic.



Corrosion Prevention

Corrosion Prevention

The 777 includes several corrosion prevention features.

DRAINAGE

These features improve drainage:

- Centerline drain path
- Stringer drain holes
- Drainage clearance at frames, stringer splices and fittings
- Increased number of skin centerline drain holes.

CORROSION RESISTANT MATERIALS

These items are new:

- Better aluminum alloys (2524-T3)
- Titanium seat tracks
- Toughened carbon fiber reinforced plastic floor beams
- Fiberglass floor panels.

FINISHES

These improve the airplane finish:

- Increased use of primer
- Corrosion inhibiting compounds.

Access for inspection is improved to permit better corrosion surveillance.

Equipment Centers

- **Antenna Locations**
- **Electronic Equipment Centers**
- **Shelf-Mounted Equipment**

Features

EASE OF ACCESS

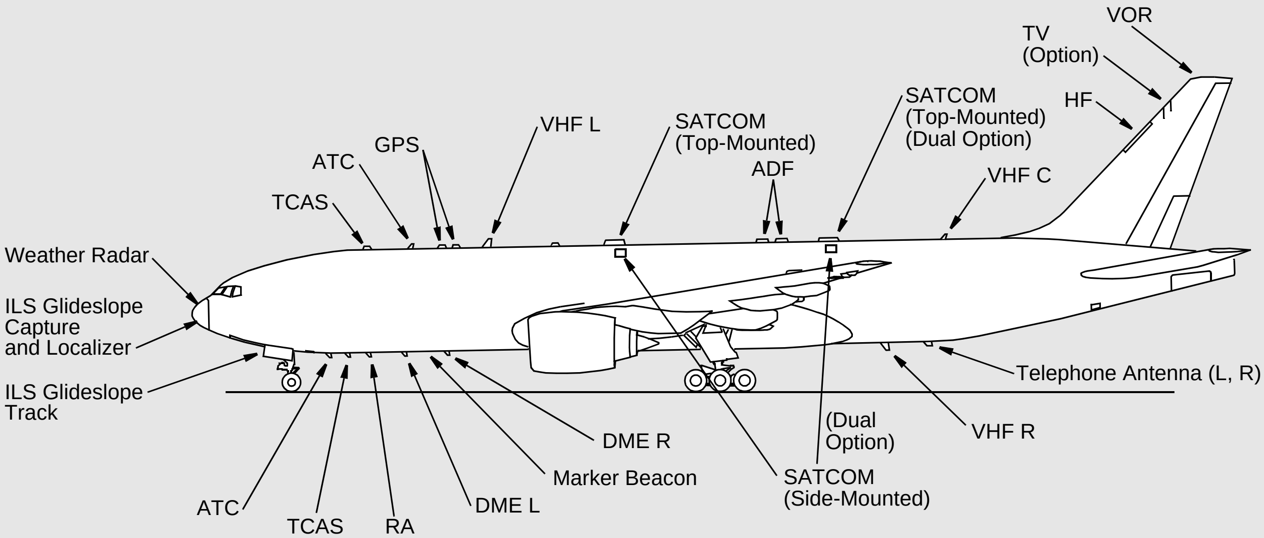
Equipment racks contain most of the electronic equipment in the airplane. The access to the racks is from the ground, passenger cabin, or cargo compartments.

REMOVAL AND INSTALLATION

The equipment centers have line replaceable units (LRUs). The LRUs are easy to remove and replace.

PASSIVE COOLING

Forced air cooling is not necessary for some LRUs. These LRUs use passive cooling. Passive cooling gives better reliability because it permits system operation with no equipment cooling operation.



Antenna Locations

Antenna Locations

The basic communication and navigation antenna locations show above.

Electronic Equipment Centers

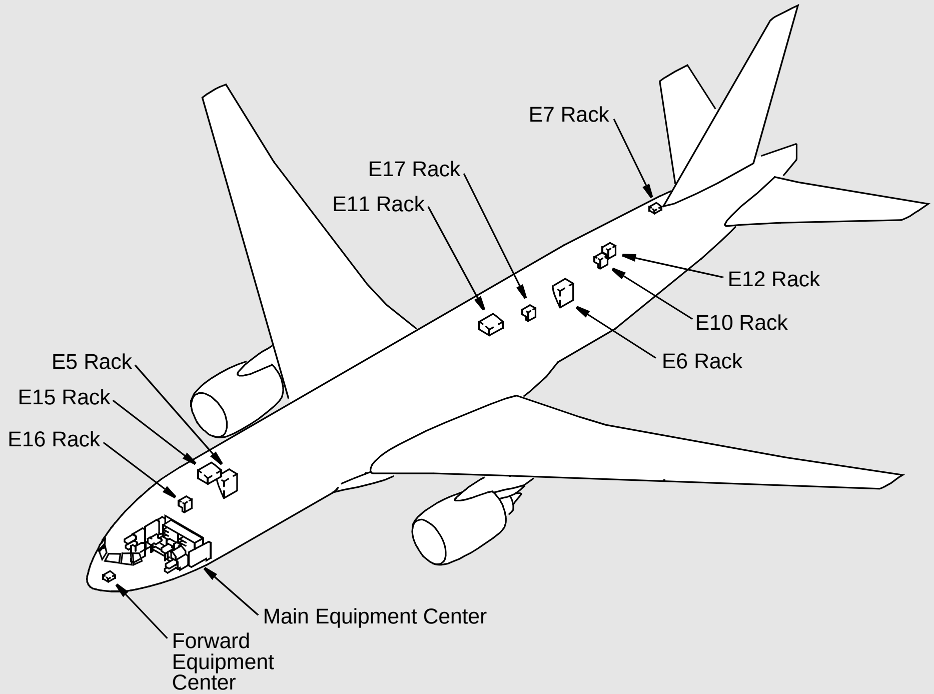
Electronic equipment racks are in different locations in the airplane. The main equipment center is below the passenger cabin floor. Access to the main equipment center is:

- From the forward cargo compartment
- Through a door on the bottom of the airplane
- Through a hatch in the passenger cabin.

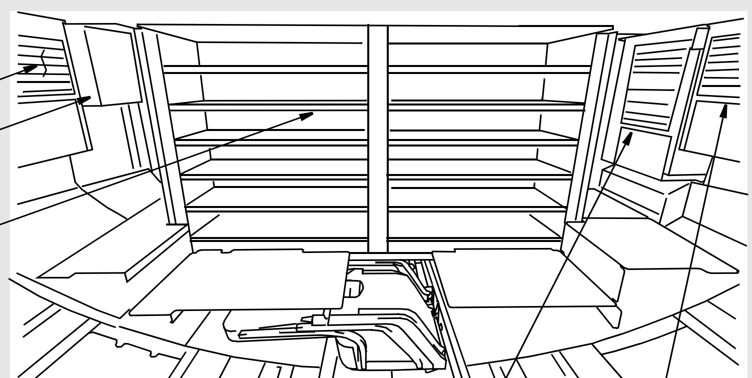
Shelf-Mounted Equipment

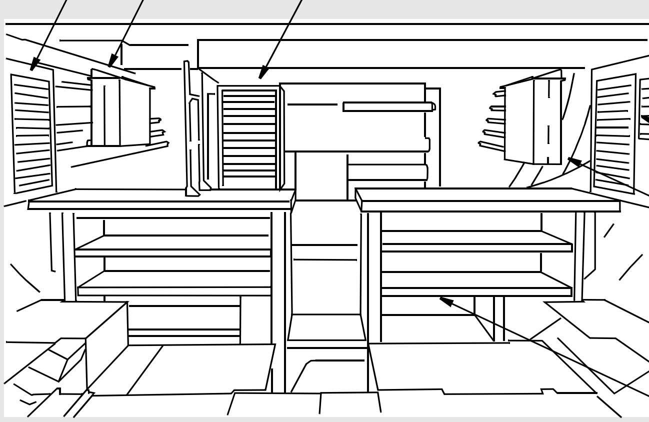
Easy to remove shelf-mounted equipment permits easy change and troubleshooting of electronic equipment. The shelves contain standard ARINC 600 line replaceable units (LRUs). The configuration of the LRUs is in relation to use and ease of access. Cooling to some LRUs is by forced air, and some LRUs have passive cooling.

Equipment Centers

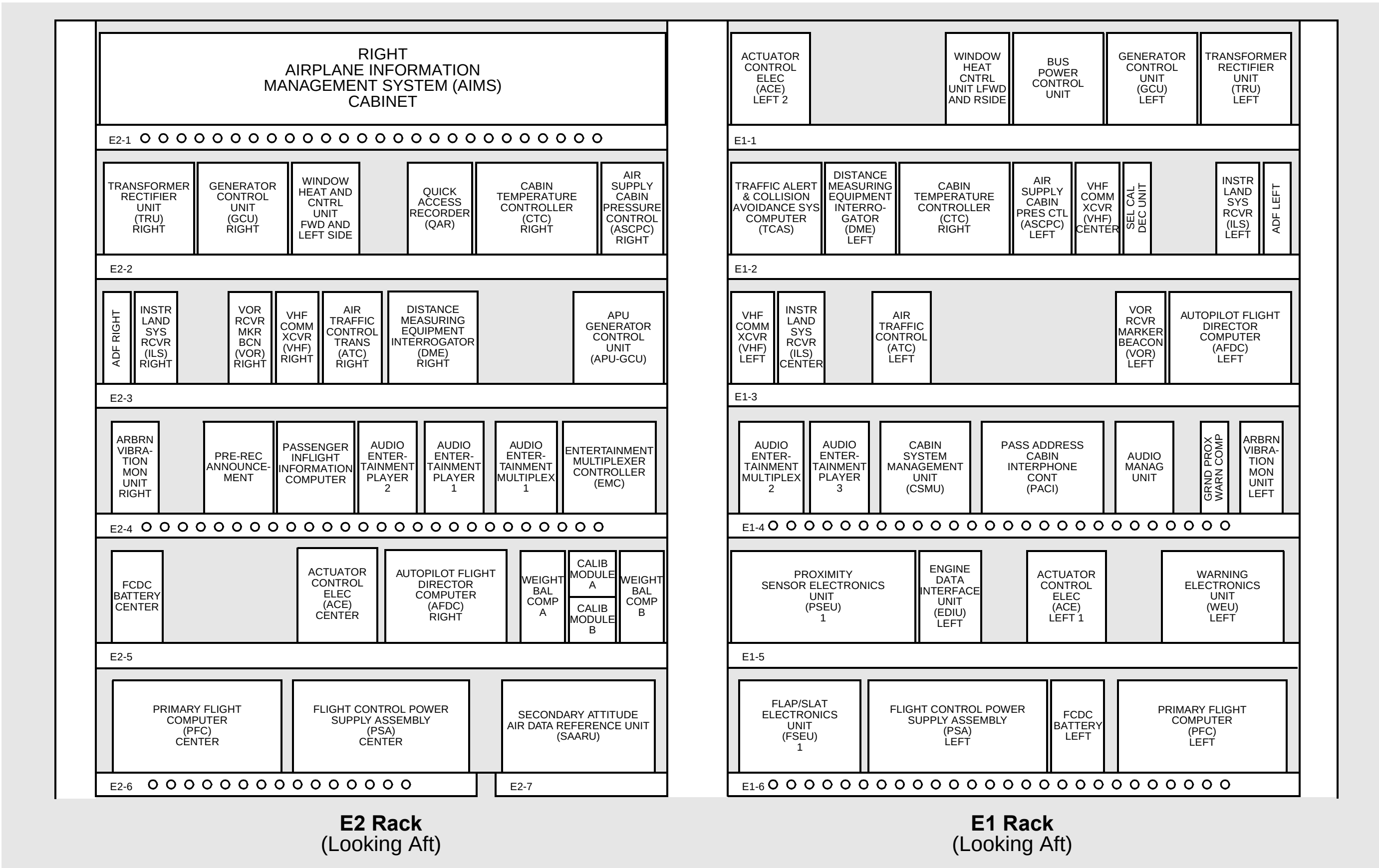


Equipment Center and Rack Locations

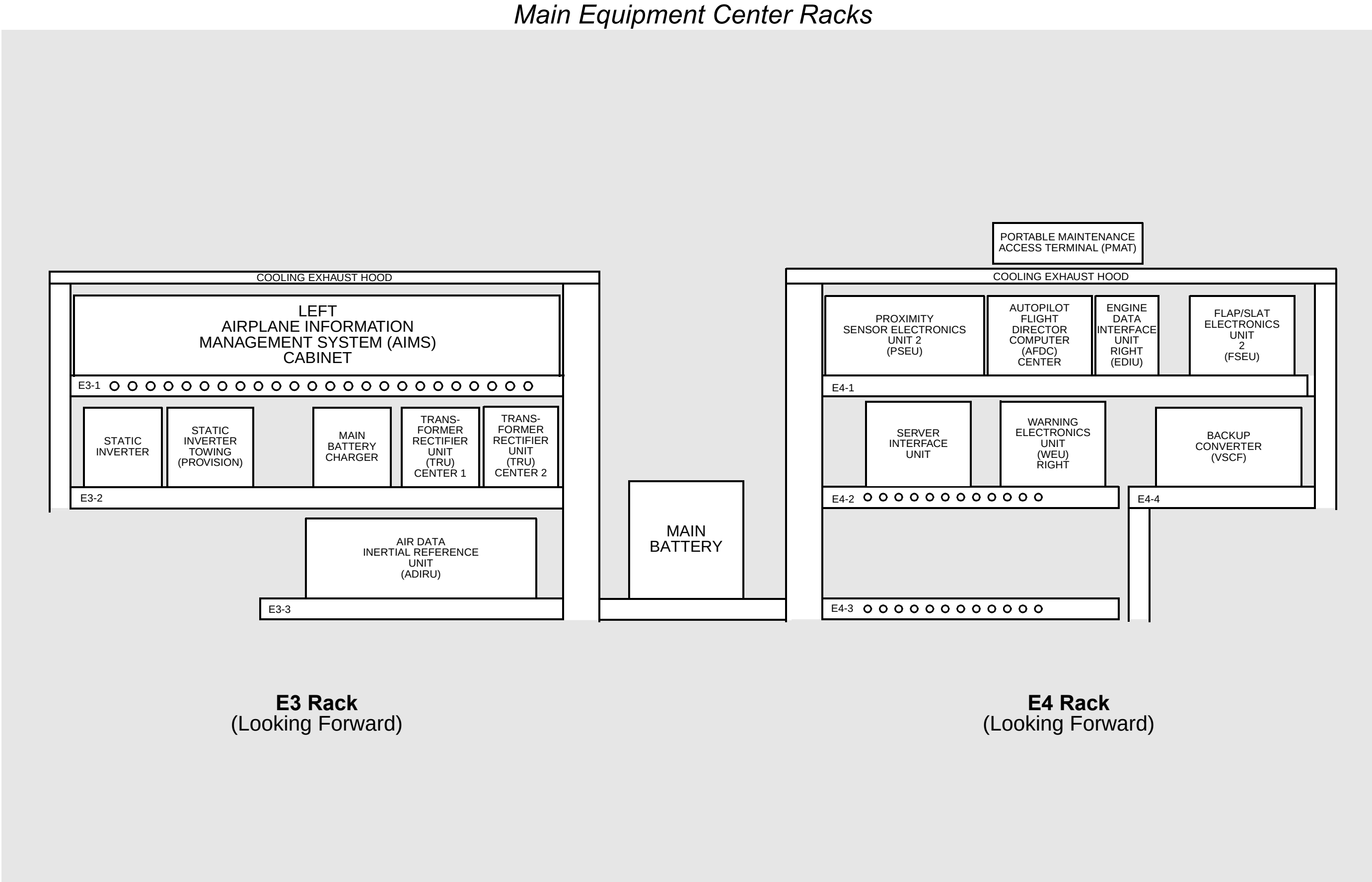




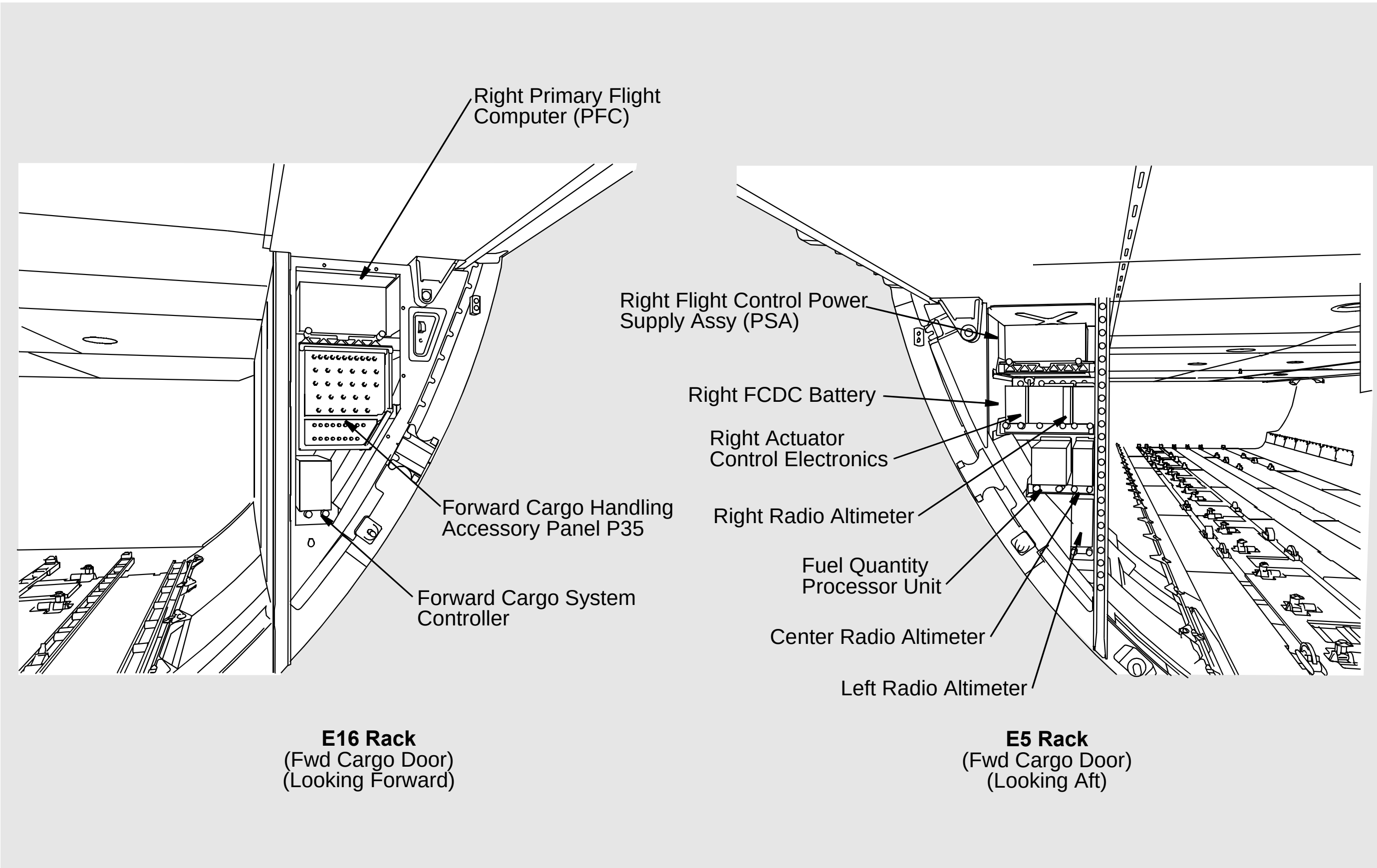
Main Equipment Center



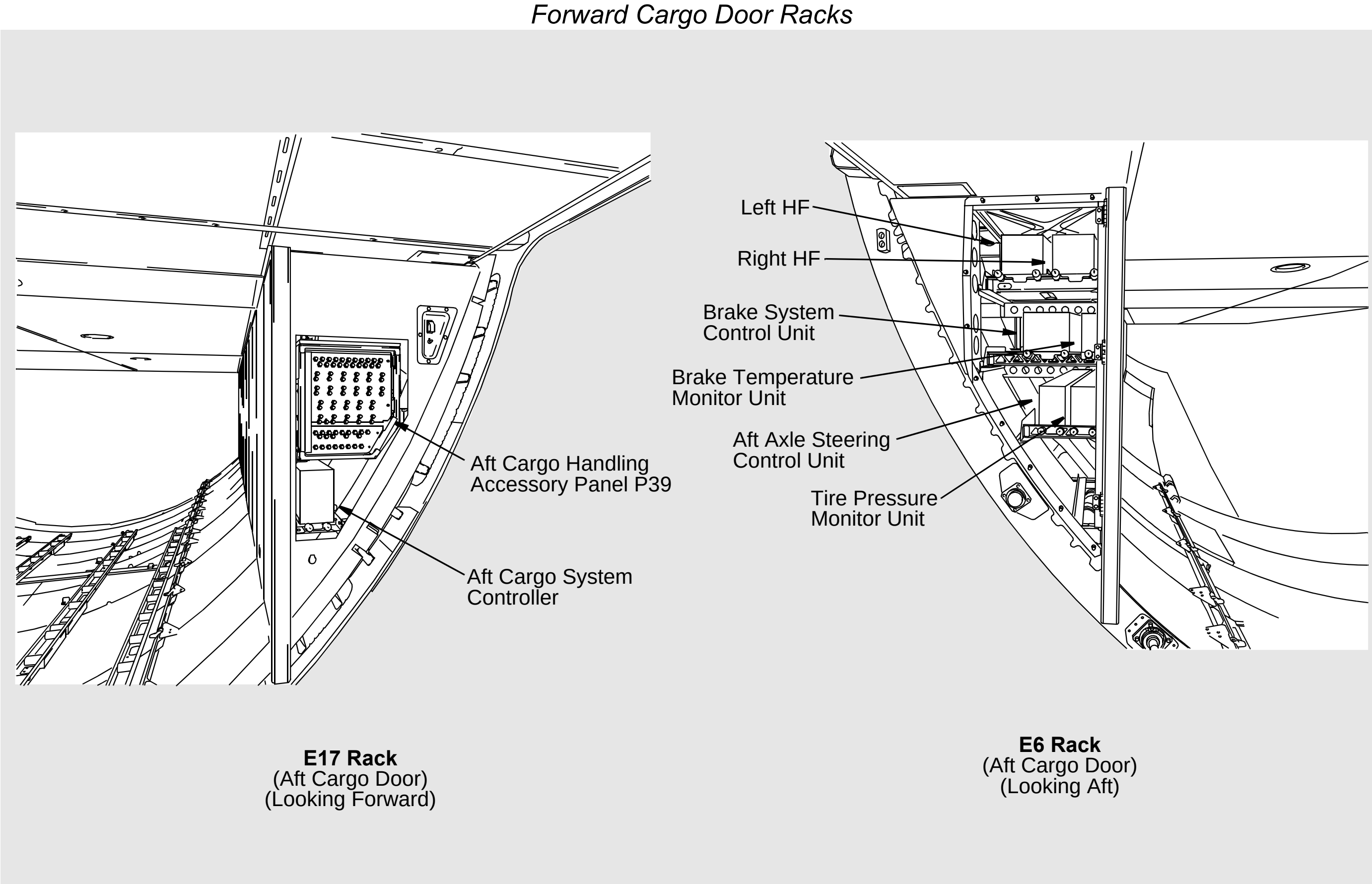
Main Equipment Center Racks



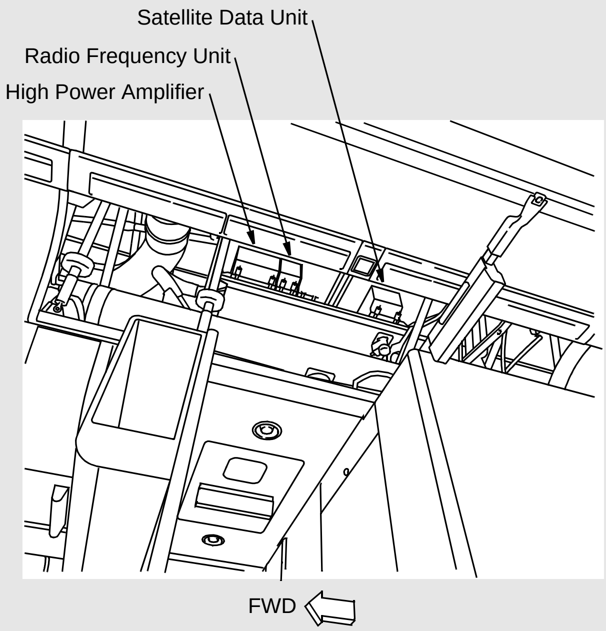
Main Equipment Center Racks



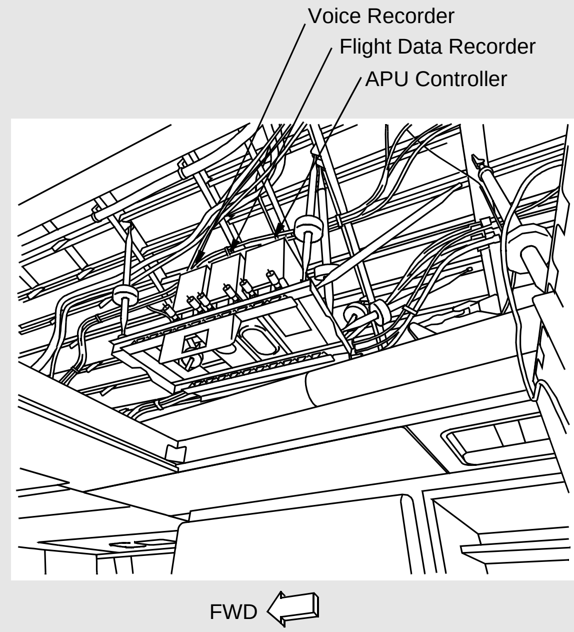
Forward Cargo Door Racks



Aft Cargo Door Racks

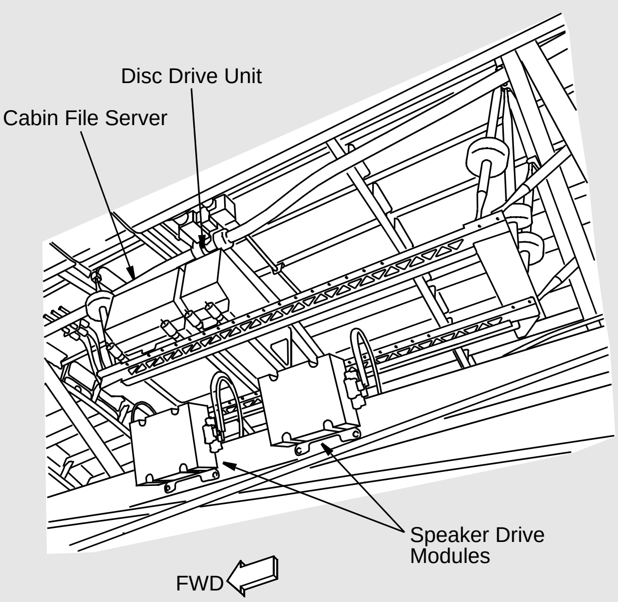


E11 Rack (Basic SATCOM)
(Overhead Passenger Compartment)
(Left Side Looking Inboard)

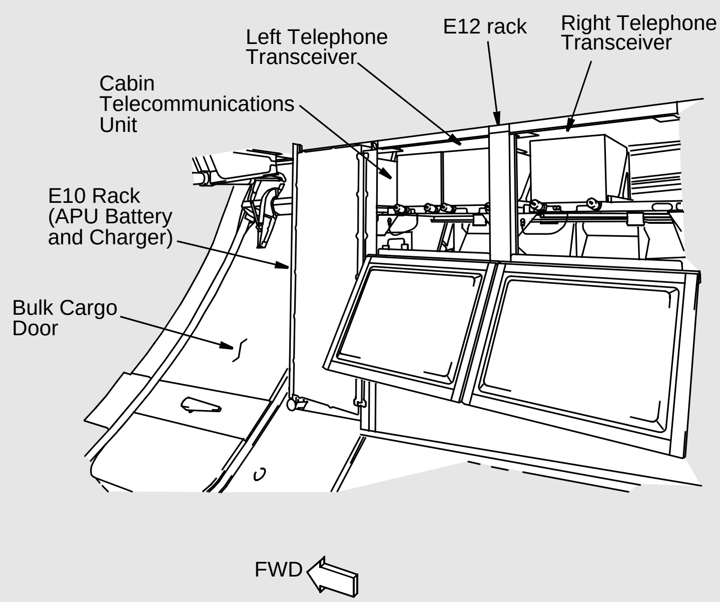


E7 Rack
(Overhead Passenger Compartment)
(Right Side Looking Outboard)

Overhead Racks in the Passenger Compartment



E15 Rack
(Overhead Passenger Compartment)
(Left Side Looking Outboard)



E10 and E12 Racks
(Bulk Cargo Compartment)
(Looking Outboard)

E10, E12, E15 Racks

Flight Deck

Features

OVERVIEW

The 777 has a two-pilot flight deck and room for two observers. The flight deck supplies airline and flight crew needs into the 21st century.

The 777 flight deck has flat panel liquid crystal display (LCD) technology and the digital flight deck technology shown successful on the 747-400, 767, and 757.

The LCDs replace cathode ray tube (CRT) displays used in other Boeing airplanes.

The manual operations on the 777 flight deck are made easier. Many of the manual flight crew operations done before are automatic in the 777. Easier manual operations and more automatic operations decrease the flight crew work load.

FLAT PANEL LIQUID CRYSTAL DISPLAY UNITS

Less power is necessary for the flat panel liquid crystal display units (DUs), and they have a larger display area than the usual CRT displays. The standby indicator is also a flat panel LCD.

CONTROL DISPLAY UNITS

Three LCD control display units (CDUs) in the flight deck have multicolored displays.

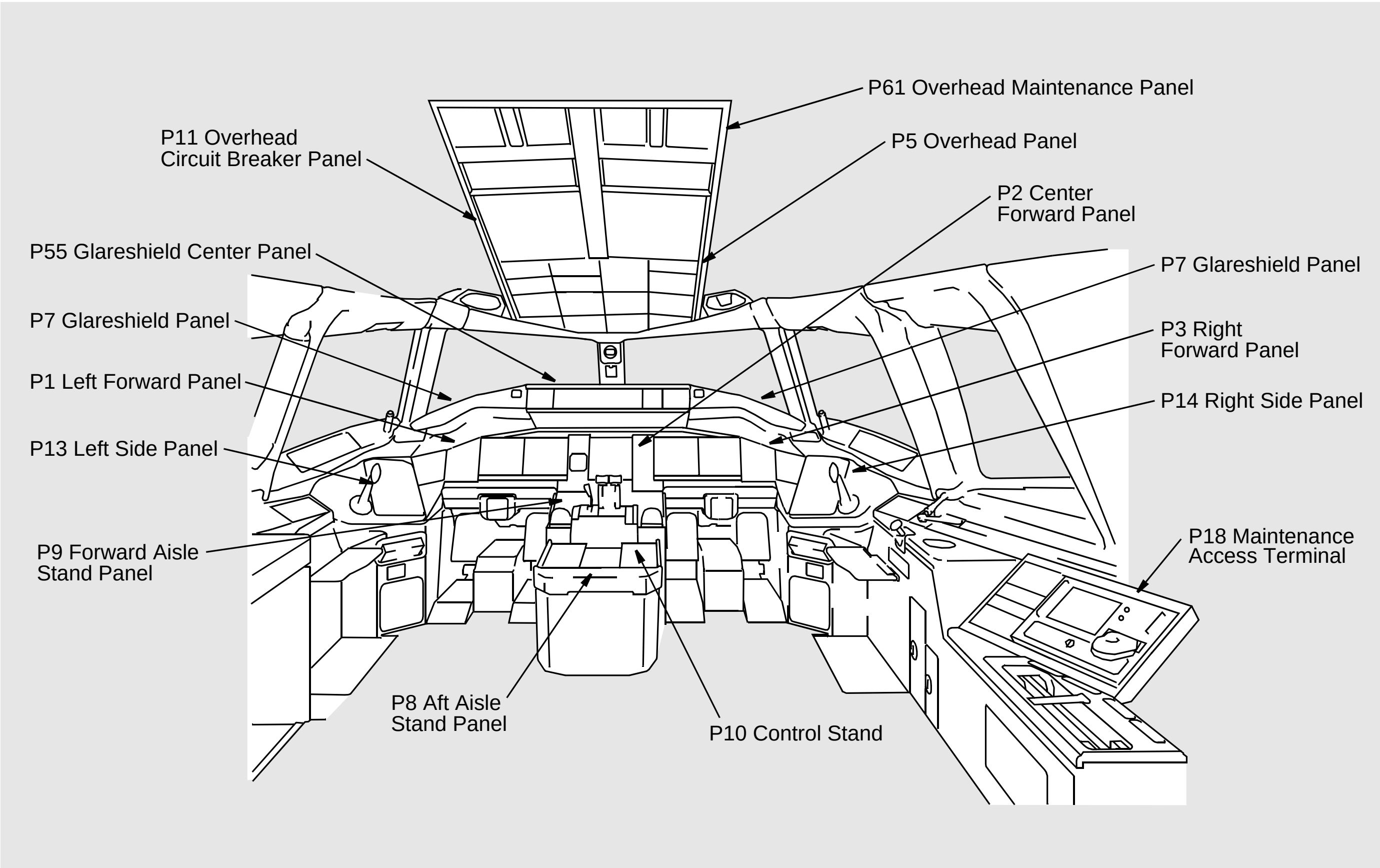
MAINTENANCE ACCESS TERMINAL

The maintenance access terminal (MAT) in the flight deck makes it easy for the maintenance crew to isolate system faults and load airplane systems software.

CURSOR CONTROL DEVICE

The flight crew and maintenance crew use the cursor control devices to request flight and other data to show on the display units that use the multi-function (MFD) formats. The maintenance access terminal (MAT) also has a cursor control device.

- **Flight Deck Panels**
- **Main Instrument Panels**
- **Center Forward Panel**
- **Glareshield Panels**
- **Control Stand**
- **Aisle Stand Panels**
- **Overhead Panels**
- **Cursor Control Device**
- **Maintenance Access Terminal**
- **Crew Seats**
- **Control Wheels and Visibility**
- **Other Flight Deck Components**



Flight Deck Panels

Flight Deck Panels

The 777 flight deck decreases and makes flight crew operations better. System control location gives easy access.

The main instrument panels of the flight deck include six 8" X 8" flat panel liquid crystal display (LCD) display units (DUs) that are the same and interchangeable. The DUs supply a larger display area than the usual cathode ray tube (CRT) displays.

The left and right outboard DUs show the primary flight display (PFD) format.

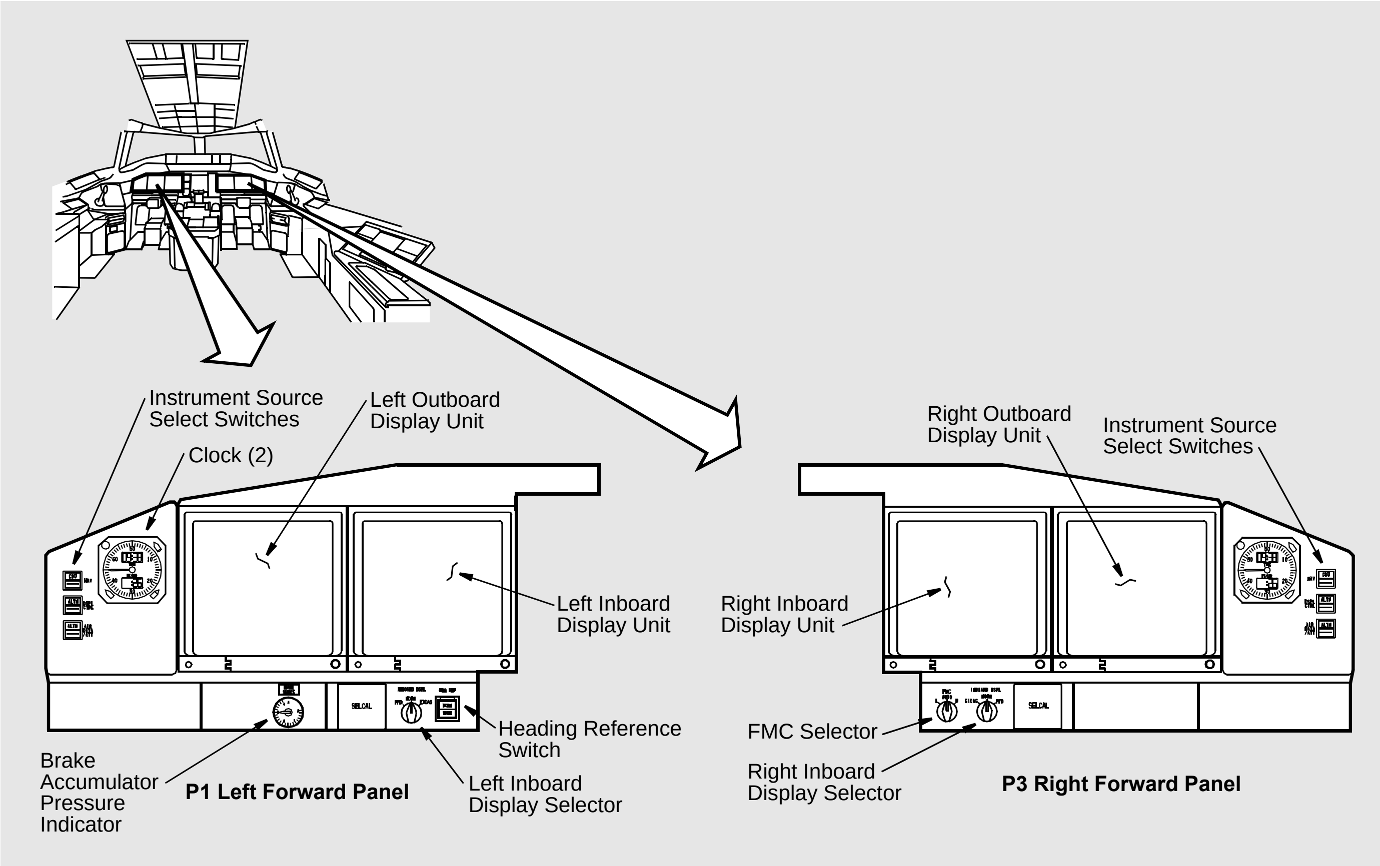
The left and right inboard DUs usually show the navigation display (ND) format. They can also show the multi-function display (MFD) formats.

The upper center DU shows the EICAS display.

The lower center DU normally shows the MFD formats. It can also show the EICAS display or the ND.

The arrangement of the captain and first officer main instrument panels decreases pilot head and eye motion and gives full visibility.

The maintenance access terminal (MAT) is a new panel that the maintenance technicians use to do many maintenance related functions.



Main Instrument Panels

Left Forward Panel

The left forward panel has these displays:

- The PFD normally on the outboard display unit
- The ND normally on the inboard display unit.

The inboard display selector permits different formats to show on the inboard display unit.

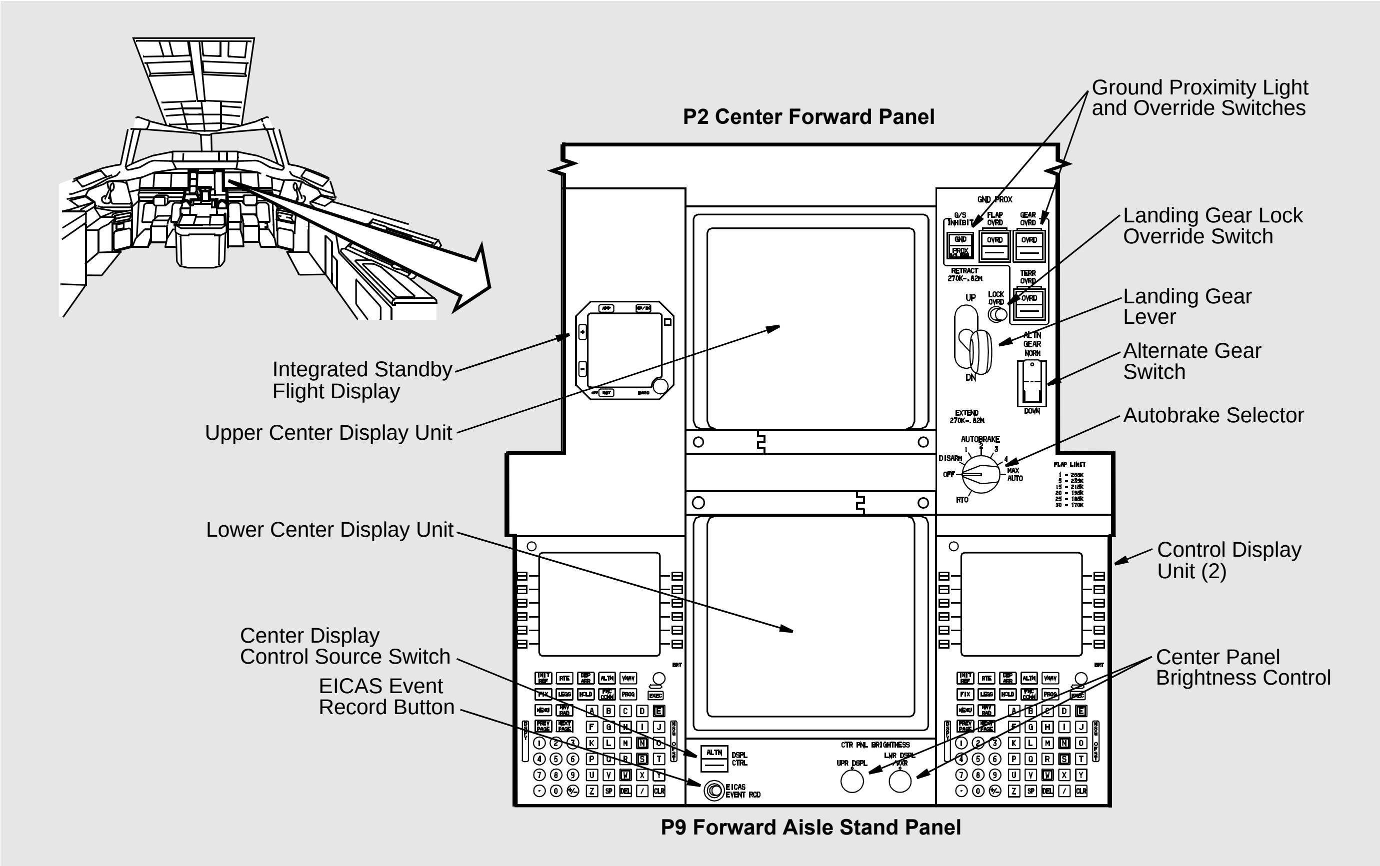
Also, the left forward panel has these components:

- Brake pressure indicator
- Heading reference switch
- Clock
- Instrument source select switches.

The instrument source select switches make it possible to select the primary or alternate source of the display data for the PFD and an alternate source of navigation data for the ND.

Right Forward Panel

The right forward panel is almost the same as the left forward panel, without the brake pressure indicator and the heading reference switch. Also, there is an FMC selector.



Center Forward Panel and Forward Aisle Stand Panel

Center Forward Panel

These are the components on the center forward panel:

- Upper center display unit
- Standby instrument for attitude, airspeed, altitude, and heading
- Ground proximity light and override switches
- Landing gear lever
- Alternate gear switch
- Autobrake selector
- Landing gear lock override switch.

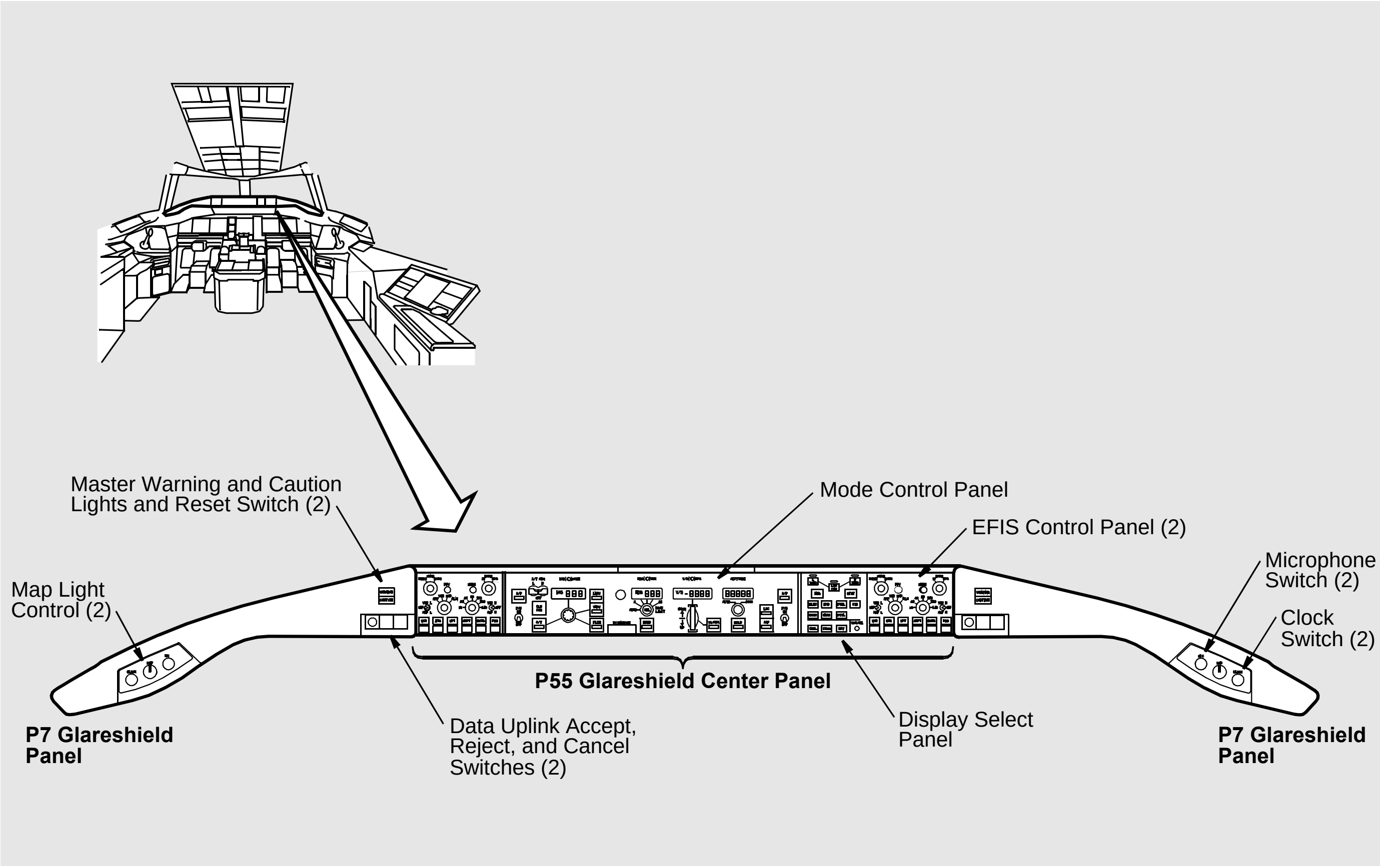
The standby instruments use the same flat panel liquid crystal display (LCD) technology as the DUs.

Forward Aisle Stand Panel

These are the components on the forward aisle stand panel:

- Lower center display unit
- Display brightness controls
- Control display units (CDUs)
- Center display source switch and brightness control
- EICAS event record button.

The CDUs use the same flat panel LCD technology as the DUs. The CDUs have a multicolored display. The multicolored CDUs show a highlight for pilot inputs, flight management command data, and other important data.

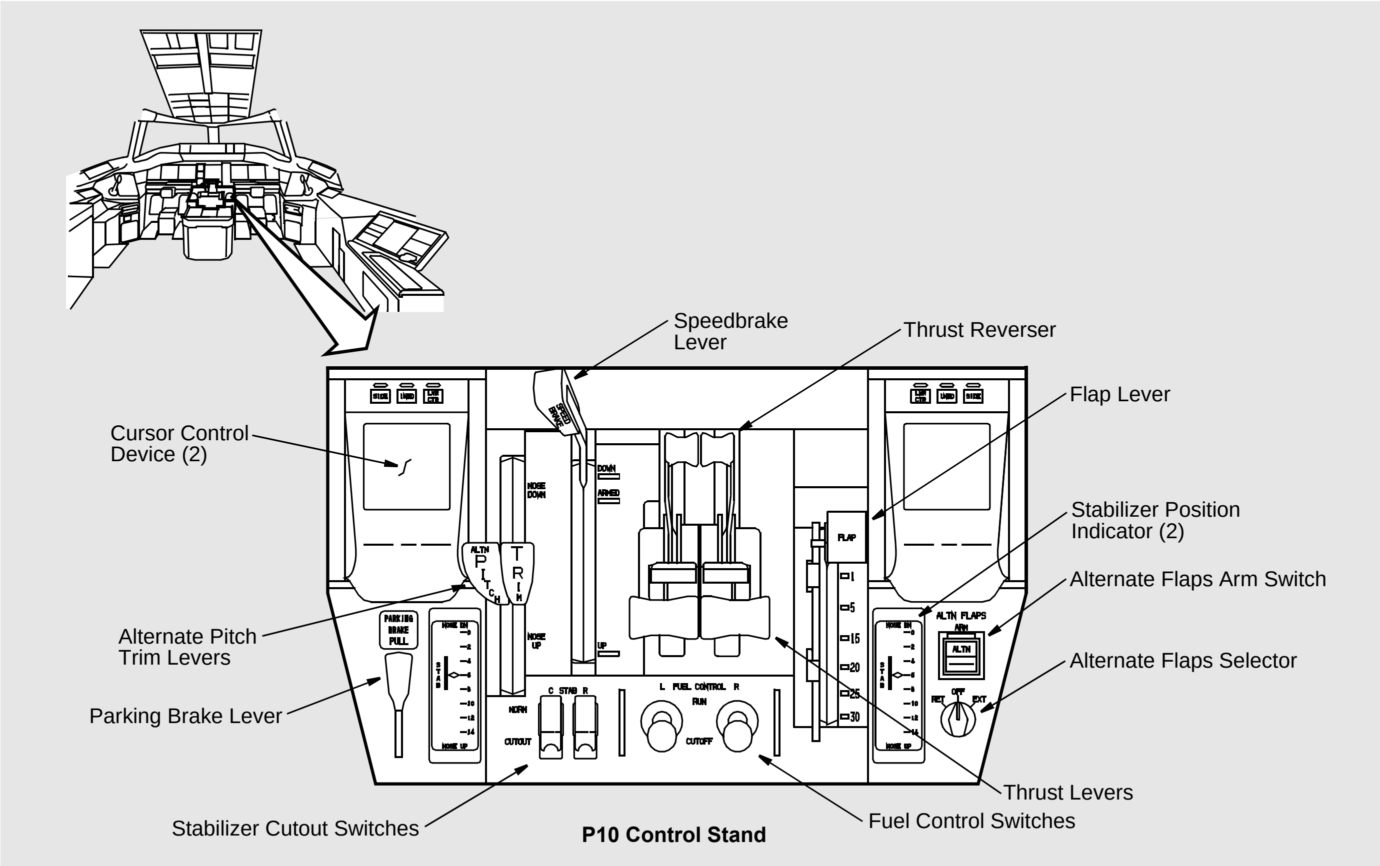


Glareshield Panels

Glareshield Panels

These are the components on the glareshield panels:

- Mode control panel
- Left and right EFIS control panels
- Display select panel
- Master warning and caution lights and reset switches
- Accept, reject and cancel switches for data uplink information
- Map light controls
- Clock switches
- Microphone switches.



Control Stand

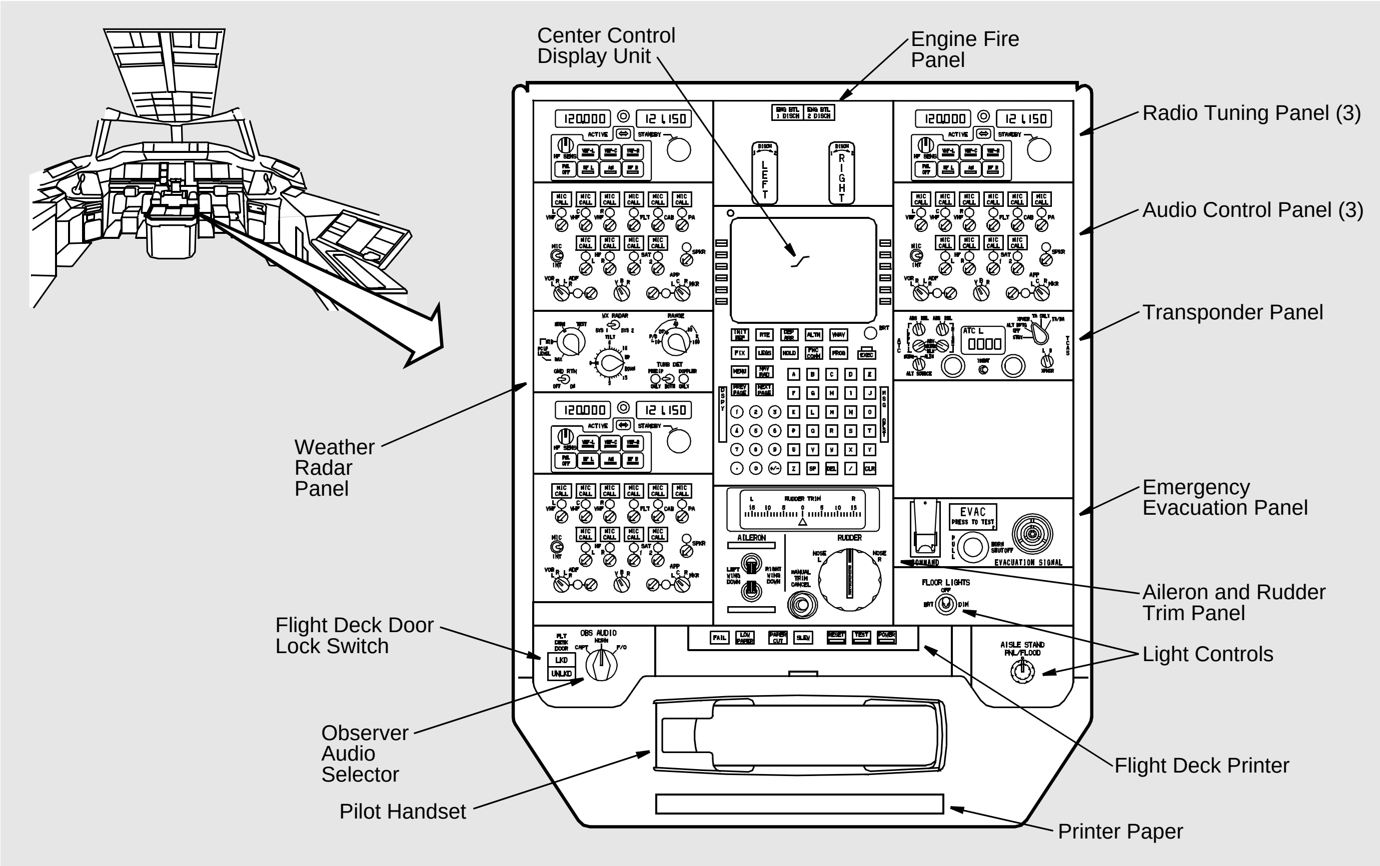
Control Stand

The control stand has controls that are easy to reach by either pilot.

These are the components on the control stand:

- Thrust levers
- Flap lever
- Stabilizer position indicators
- Alternate flaps controls
- Fuel control switches
- Stabilizer cutout switches
- Parking brake lever
- Alternate pitch trim levers
- Speedbrake lever.

The control stand also has two cursor control devices. The cursor control devices let the flight crew make selections on some multi-function displays.



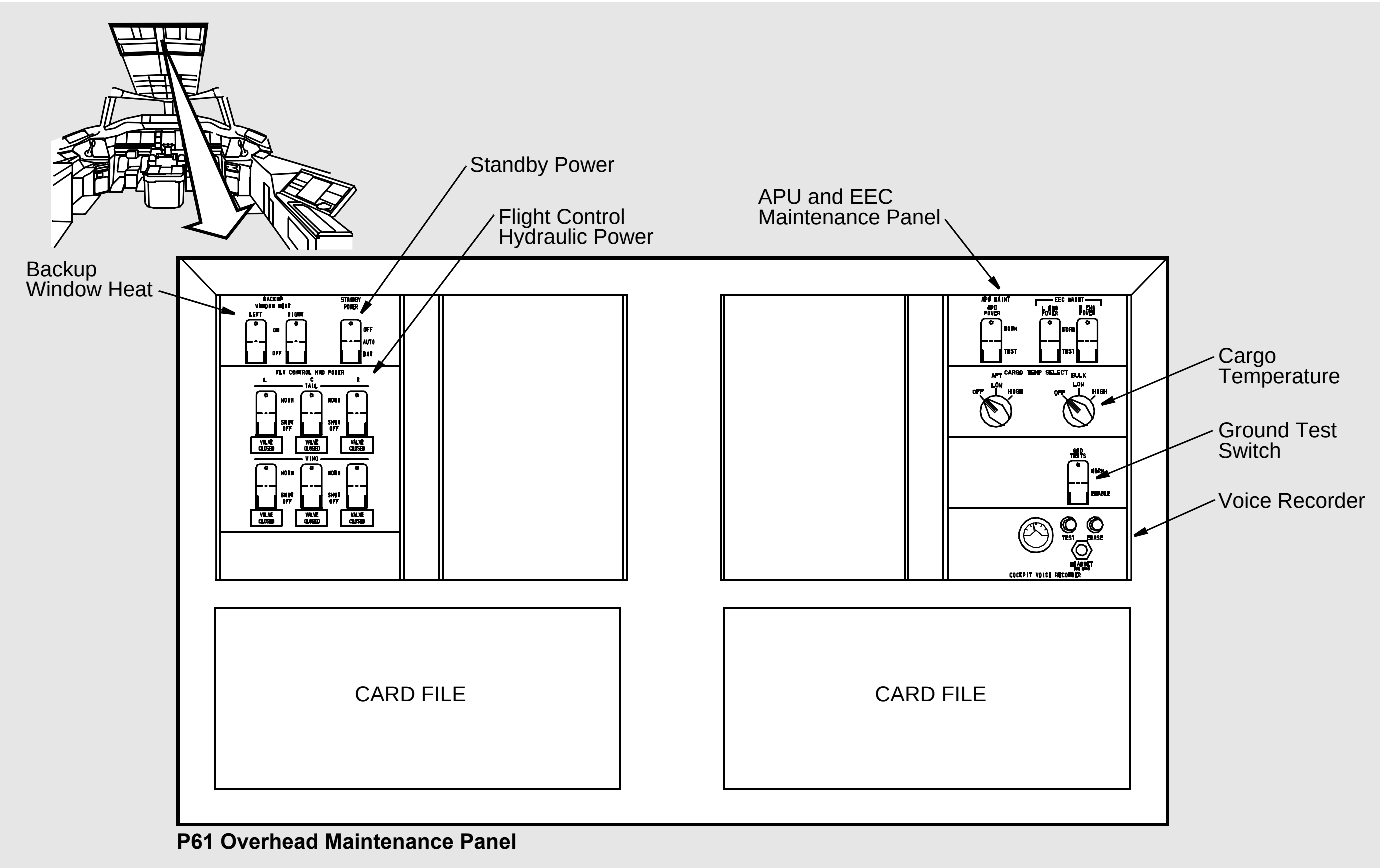
Aft Aisle Stand Panel

Aft Aisle Stand Panel

The aft aisle stand has easy to reach controls and easy to see indications.

These are the components on the aft aisle stand panel:

- Engine fire panel
- Three radio tuning panels
- Three audio control panels
- Transponder panel
- Emergency evacuation panel
- Aileron and rudder panel
- Light controls
- Full size 8 1/2" x 11" flight deck printer
- Pilot handset
- Observer audio selector
- Flight deck door lock switch
- Weather radar control
- A multicolored CDU.



Overhead Maintenance Panel

Overhead Maintenance Panel

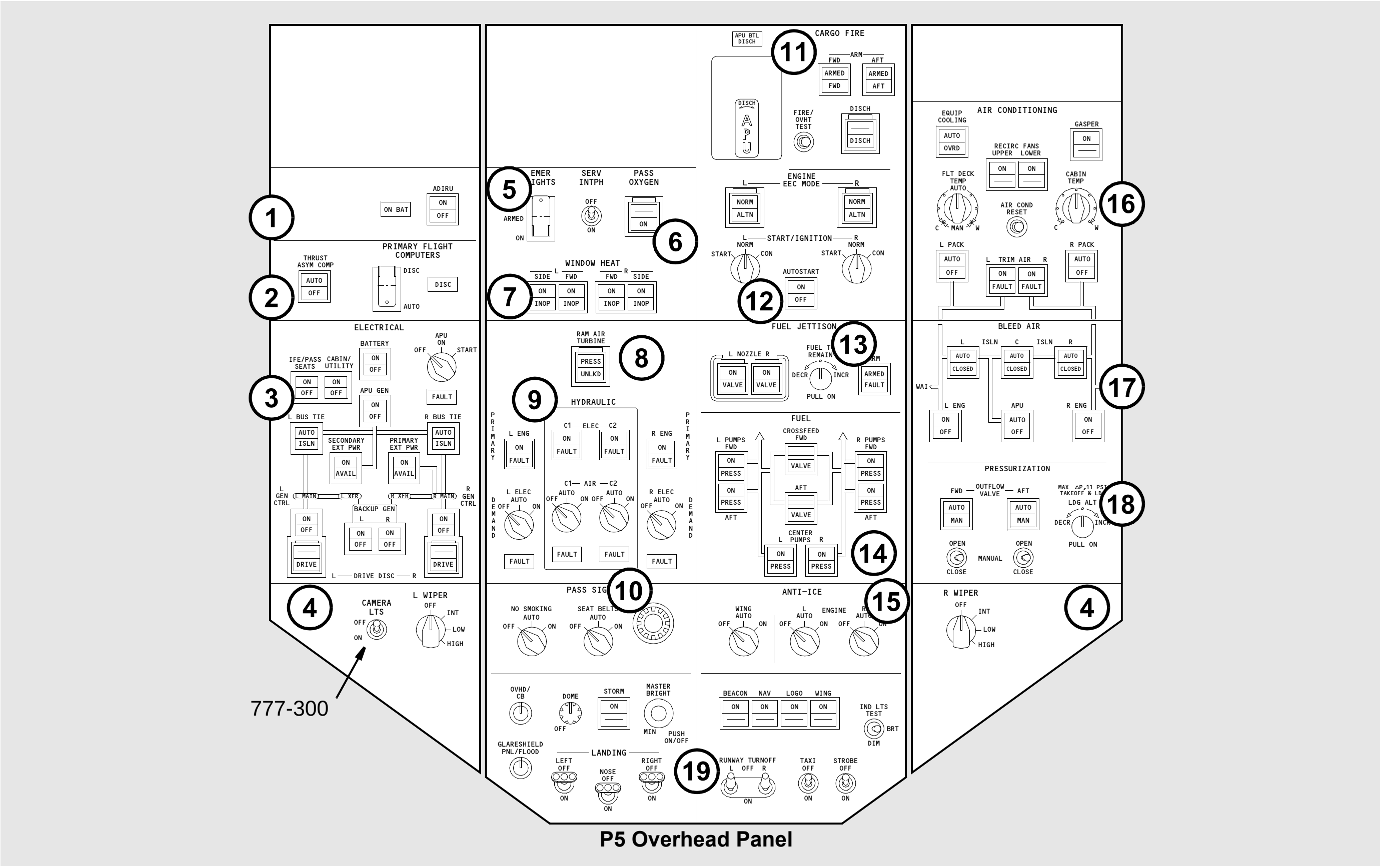
The overhead maintenance panel has the controls that are set before takeoff or during ground maintenance and do not require adjustment during flight.

These are the functions on the overhead maintenance panel:

- Backup window heat controls
- Standby power
- Flight control hydraulic power controls
- APU and EEC maintenance controls
- Cargo temperature control
- Ground test switch
- Voice recorder
- Card files.

Each card file has two interface cards. These interface cards are the interface between the switch signals from the overhead panels and two overhead panel bus controllers. The bus controllers convert the switch signals into ARINC 629 data and send them on the ARINC 629 buses to the airplane systems.

Two panel data concentrator units under the main instrument panels, supply the interface between the switch signals from the instrument panels and the overhead panel bus controllers.



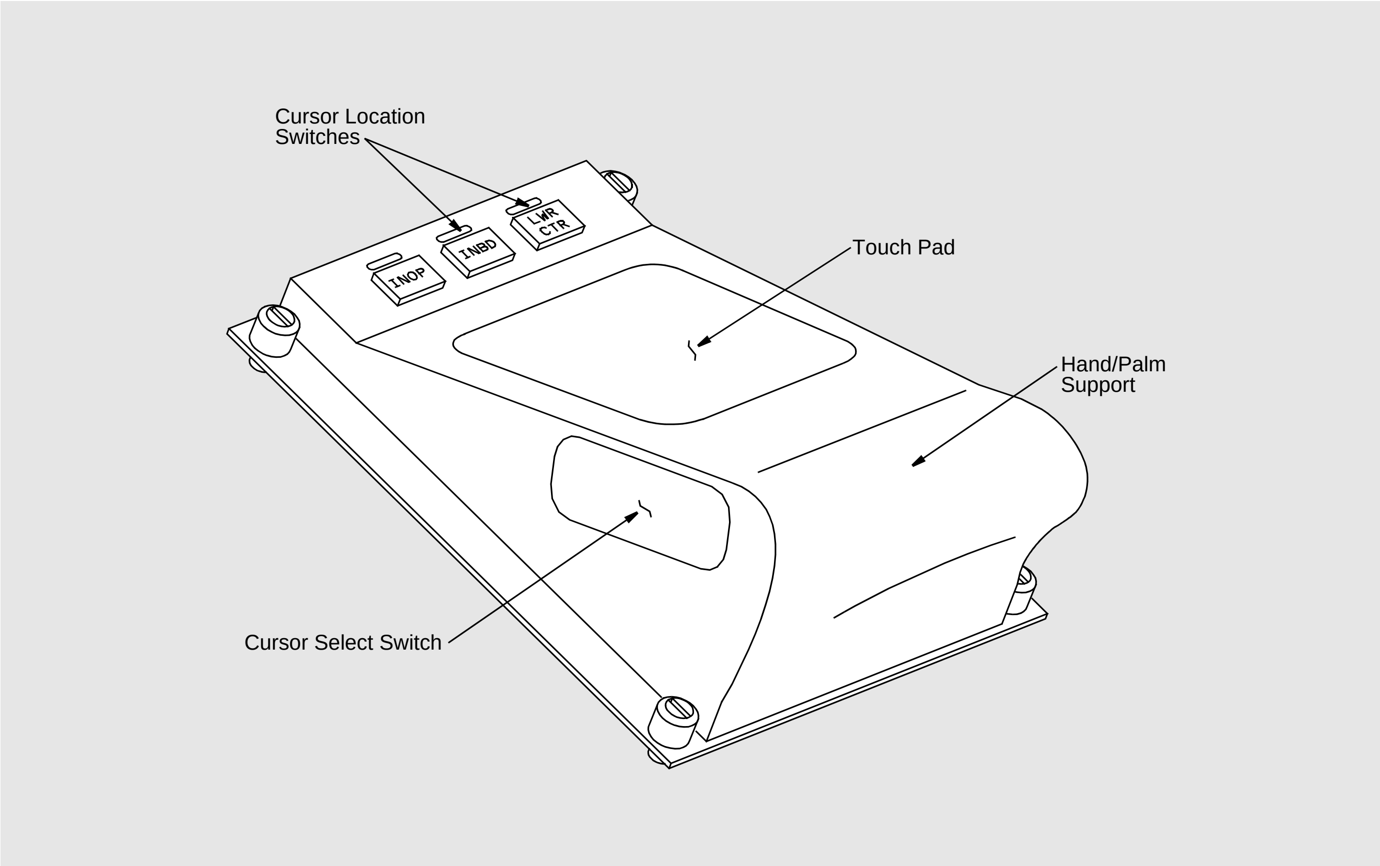
Overhead Panel

Overhead Panel

Because of its central location, either pilot can reach any of the systems controls. The two outboard columns of the overhead panel have a five-degree angle inward. This increases the visibility across the panel.

The overhead panel includes controls and indications for these functions:

- 1 - Air data inertial reference system control
- 2 - Primary flight computer disconnect
- 3 - Electrical system/APU
- 4 - Wiper control
- 5 - Emergency lighting
- 6 - Passenger oxygen
- 7 - Window heat
- 8 - Ram air turbine switch
- 9 - Hydraulic system
- 10 - Passenger signs
- 11 - APU and cargo fire control
- 12 - Engine start
- 13 - Fuel jettison
- 14 - Fuel management
- 15 - Anti-ice
- 16 - Air conditioning
- 17 - Bleed air
- 18 - Pressurization
- 19 - Lighting.



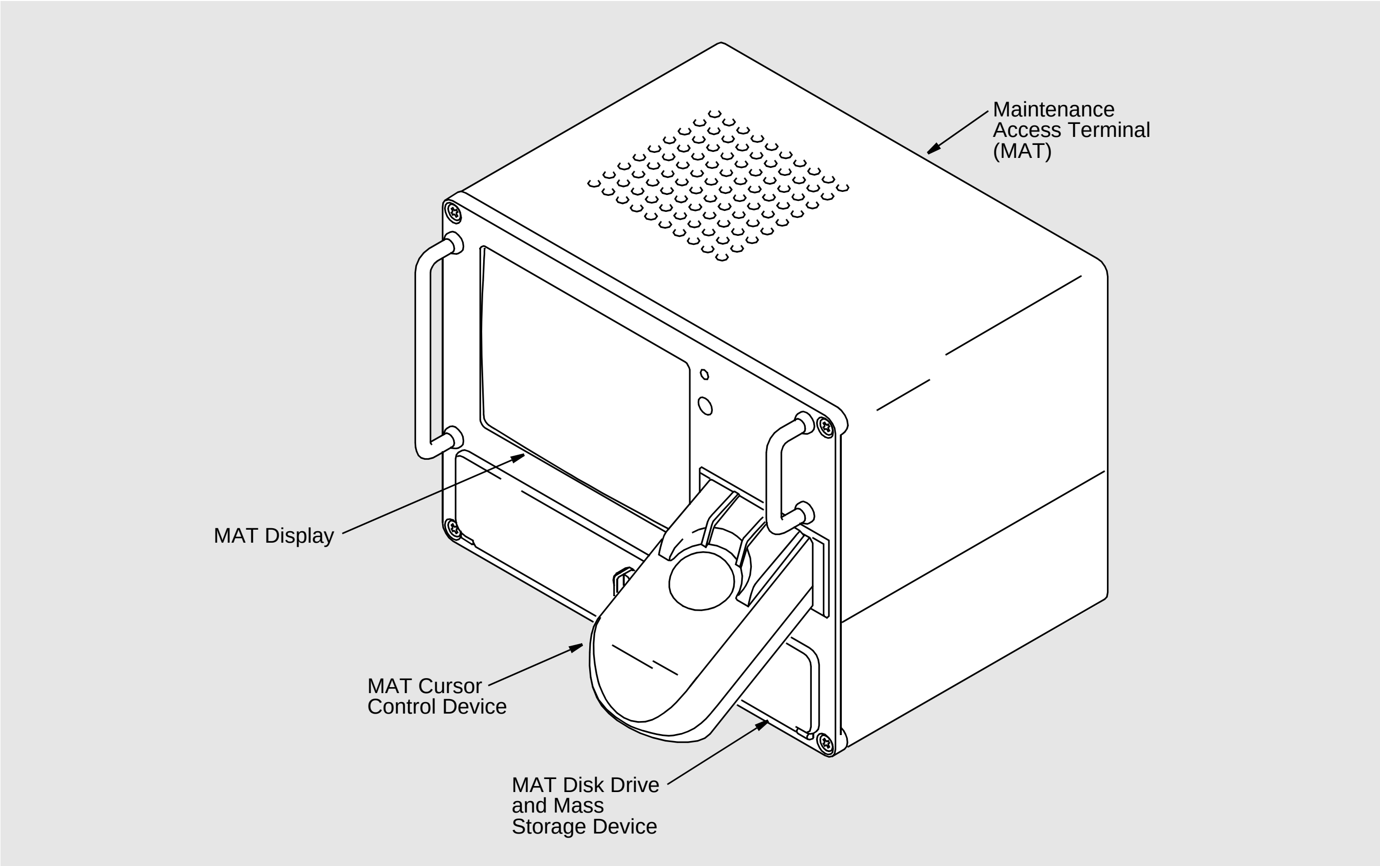
Cursor Control Device

Cursor Control Device

Two cursor control devices (CCDs) on the control stand make it possible to access some communication systems and get real-time maintenance information from the MFD.

With the CCDs on the control stand, the flight crew or maintenance crew uses the cursor location switches to select the inboard displays or lower center display for maintenance information.

The touch sensitive pad of the cursor control device permits control of the cursor position on the active display. When the cursor is in the desired position, push the cursor select switch to activate the selection.



Maintenance Access Terminal

Maintenance Access Terminal

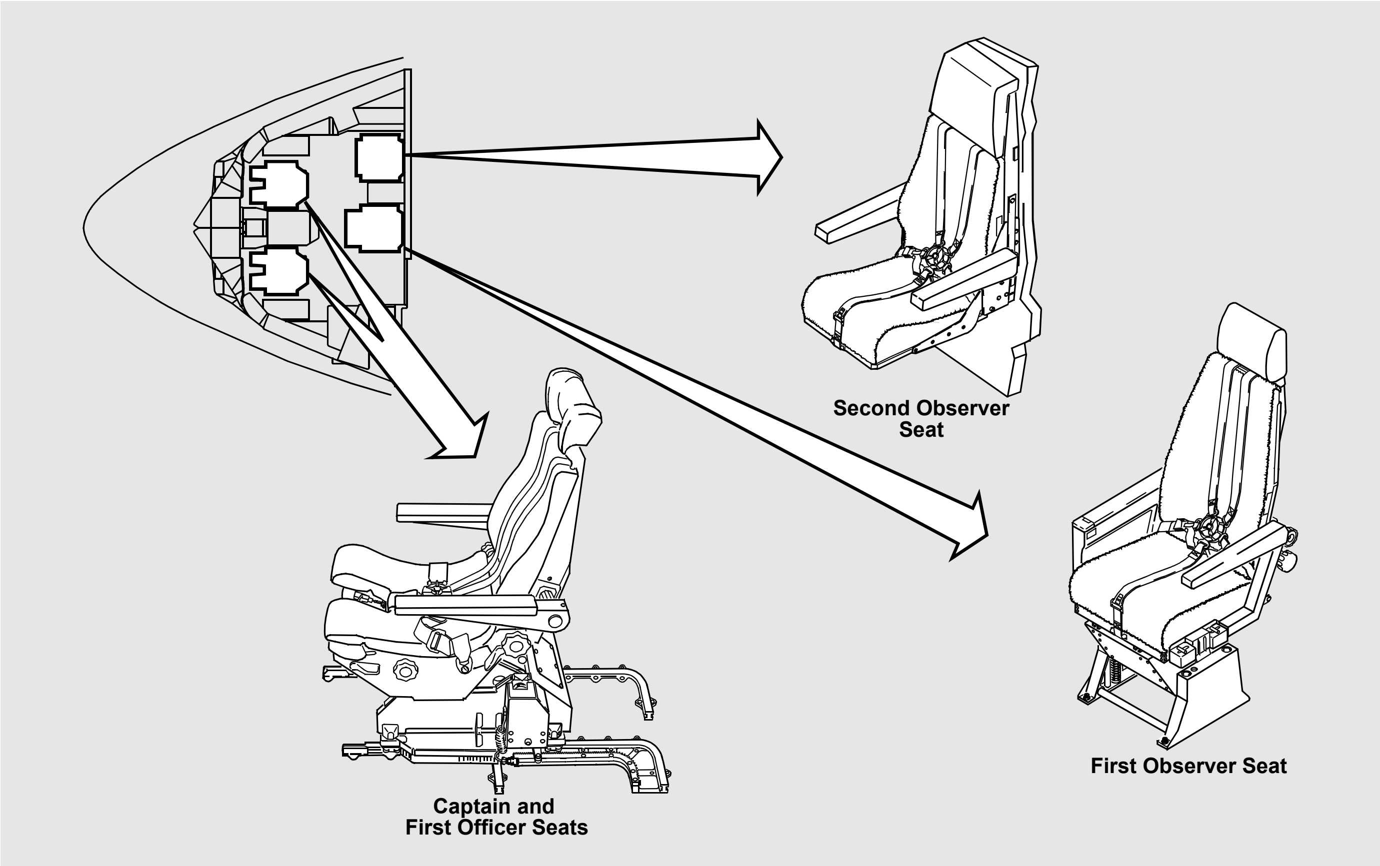
The maintenance access terminal (MAT) at the second observer position makes it possible for the maintenance crew to do these functions:

- Request system and component fault and maintenance information
- Do ground tests of airplane systems and components
- Load software into the components that need onboard software loads.

The MAT includes these components:

- Display
- Cursor control device
- Disk drive
- Mass storage device
- Keyboard.

There are several portable MAT (PMAT) interfaces in various positions on the airplane.



Crew Seats

Crew Seats

Crew seats in the 777 are made for comfort and convenience. The captain and first officer seats electrically adjust in the vertical and forward/aft directions. The captain and first officer seats have these adjustments:

- Recline
- Vertical
- Forward and aft
- Thigh support
- Lumbar region of the back.

The captain and first officer seats have these features:

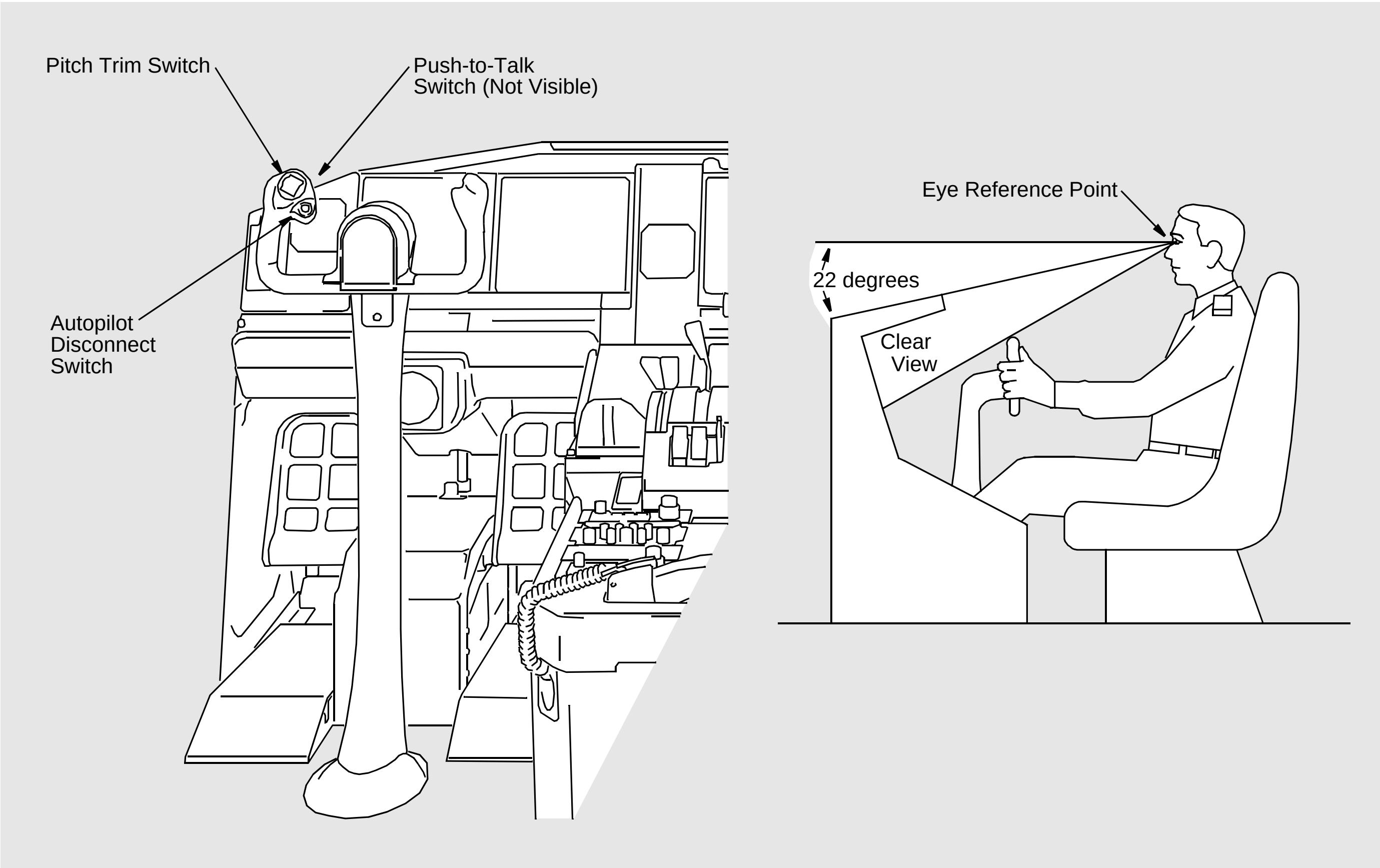
- Arm rests that fold
- Crotch strap
- Inertia-reel shoulder harness with manual lock
- Lap belt
- Headrest.

The first observer seat mounts on a pedestal. It adjusts manually in the vertical and forward/aft directions. The first observer seat has these features:

- Arm rests that fold
- Crotch strap
- Inertia-reel shoulder harness
- Lap belt
- Headrest.

The second observer seat is not adjustable.The second observer seat has these features:

- Arm rests that fold
- Crotch strap
- Shoulder harness
- Lap belt
- Headrest.



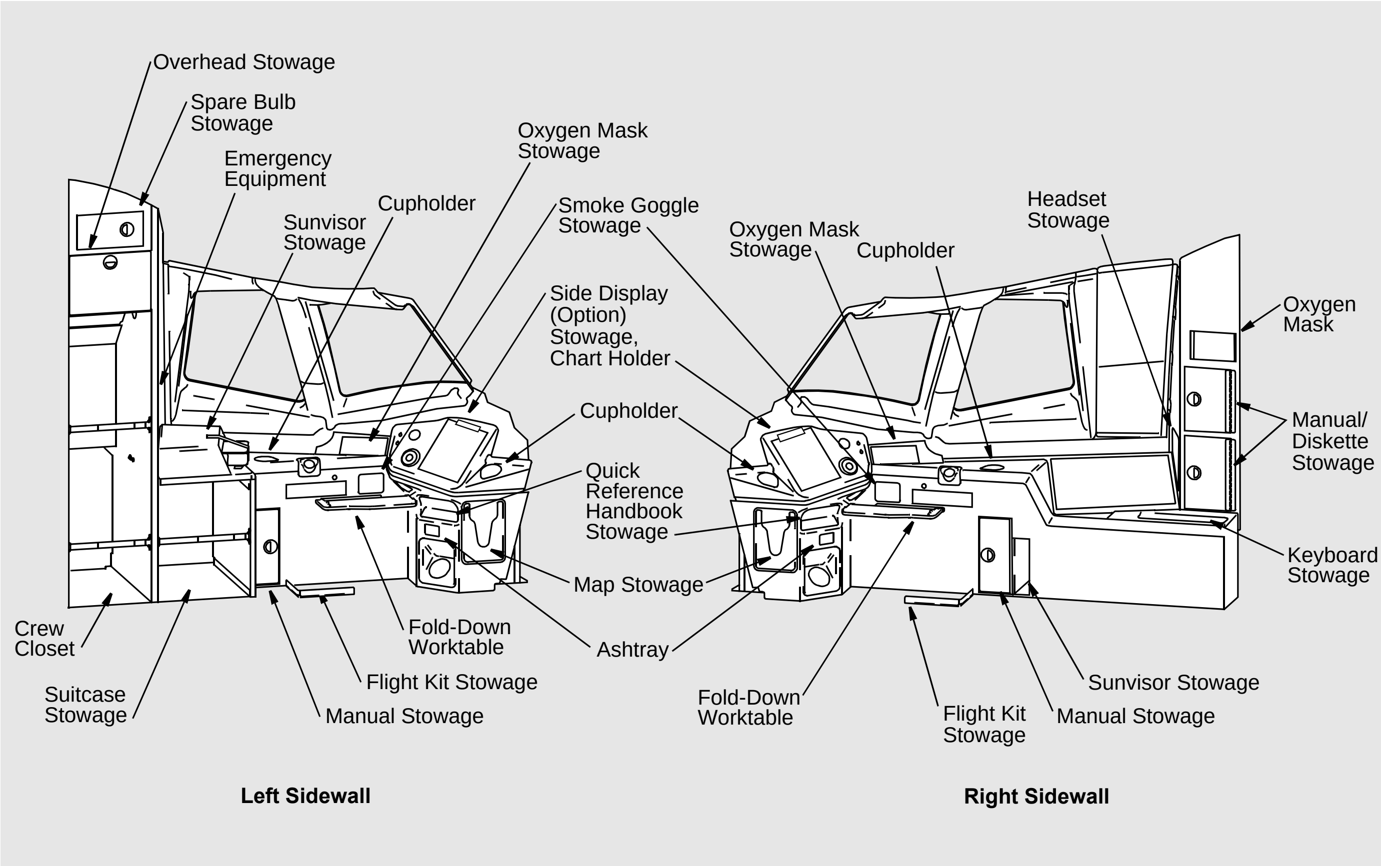
Control Wheel and Visibility

Control Wheel and Visibility

Each control wheel includes these functions:

- Pitch trim switches
- Autopilot disconnect switch
- Oxygen mask or boom microphone push-to-talk (PTT) switch.

When the pilots adjust their seats so that their eyes are at the eye reference point (ERP), the control column design permits a clear view of all flight instruments.



Flight Deck Components

Other Flight Deck Components

Necessary equipment in the flight deck includes:

- Emergency equipment
- Manual stowage
- Flight kit stowage
- Smoke goggles
- Oxygen masks
- Suitcase stowage
- Cup holders.

Optional side displays on the P13 and P14 panels show flight crew selected data such as aeronautical charts.

Airplane Information Management System

Features

INTEGRATED FUNCTIONS

The airplane information management system (AIMS) is a new system introduced on the Boeing 777 airplane. Advancements in technology, microelectronics, fault tolerance, and software permit the development of highly integrated, digital avionics. The AIMS integrates the avionics functions that require large quantities of data collection, processing, and calculations. On other model airplanes, many LRUs are necessary to handle these avionics functions.

AIMS CABINETS

The AIMS has two cabinets. Each cabinet has eight line replaceable modules (LRMs), four of these are input/output modules (IOMs) and four are core processor modules (CPMs). The AIMS cabinets operate as the main computer for several avionics systems.

The AIMS cabinet integrates the computing functions for the avionics systems. Software partitioning keeps a necessary separation between computing functions. The software partitioning allows the integration of multiple computing functions in a single core processor module.

SYSTEM INTERFACES

The AIMS cabinets interface with approximately 130 LRUs, sensors, switches, and indicators. The large quantity of interfaces permits the AIMS to integrate the information from a majority of airplane systems in one place. It is efficient to integrate this information for central maintenance computing, flight data recording, airplane condition monitoring flight management, thrust management and displays.

FLIGHT CREW INTERFACE

These components are used with the AIMS:

- EFIS control panel (2)
- Display select panel
- Control display unit (CDU) (3)
- Display switching panels (2)
- Cursor control device (2).

The two cursor control devices (CCDs) in the flight deck are new features. The flight crew uses the CCDs to:

- Control menus
- Select items on the multi-function display
- Manage communications.

MAINTENANCE INTERFACE

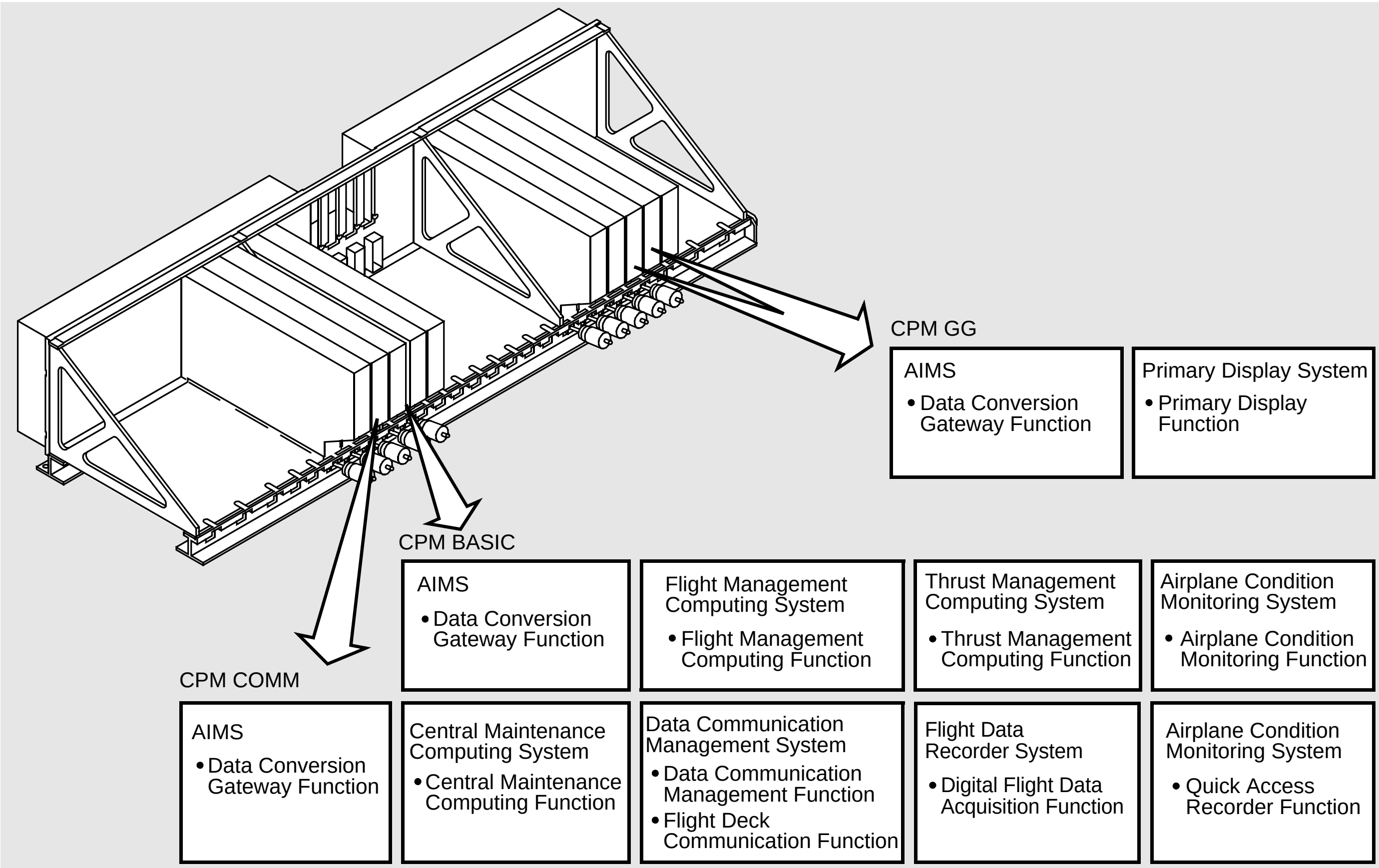
The onboard maintenance system uses the AIMS cabinets for the computing function. The maintenance crew uses a maintenance access terminal (MAT) to control the central maintenance computing system and the airplane condition monitoring system. The MAT is a station with a display module, disk drive module, keyboard, and cursor control module. The MAT is at the second observer position.

ENGINEERING INTERFACE

Engineers use the ground based software tool (GBST) to create airline modifiable information (AMI). The AMIs allow the airline to customize information. The AMI software is loaded into these functions:

- ACMF
- CMCF
- DCMF
- FDCF
- FMCF
- PDF.

- **Airplane Information Management System**
- **Data Conversion Gateway Function**
- **Primary Display System**
- **Flight Management Computing System**
- **Thrust Management Computing System**
- **Central Maintenance Computing System**
- **Airplane Condition Monitoring System**
- **Flight Data Recording System**
- **Ground Manuever Camera System**
- **Data Communication Management System**



Airplane Information Management System

Airplane Information Management System (AIMS)

The AIMS has two cabinets in the main equipment center. Each cabinet has ten line replaceable modules (LRMs.) They are the:

- Core processing module/communications (CPM/Comm)
- CPM/graphics generator (CPM/GG) (2)
- Input output module (IOM) (4)
- CPM/basic (right AIMS cabinet only)
- CPM/airplane condition monitoring function (CPM/ACMF) (left AIMS cabinet only).
- Power conditioning modules (2)

There is a backplane bus in each AIMS cabinet. This bus controls all data communication between the eight LRMs in the AIMS cabinet.

The LRMs do the main calculation for these seven avionic systems:

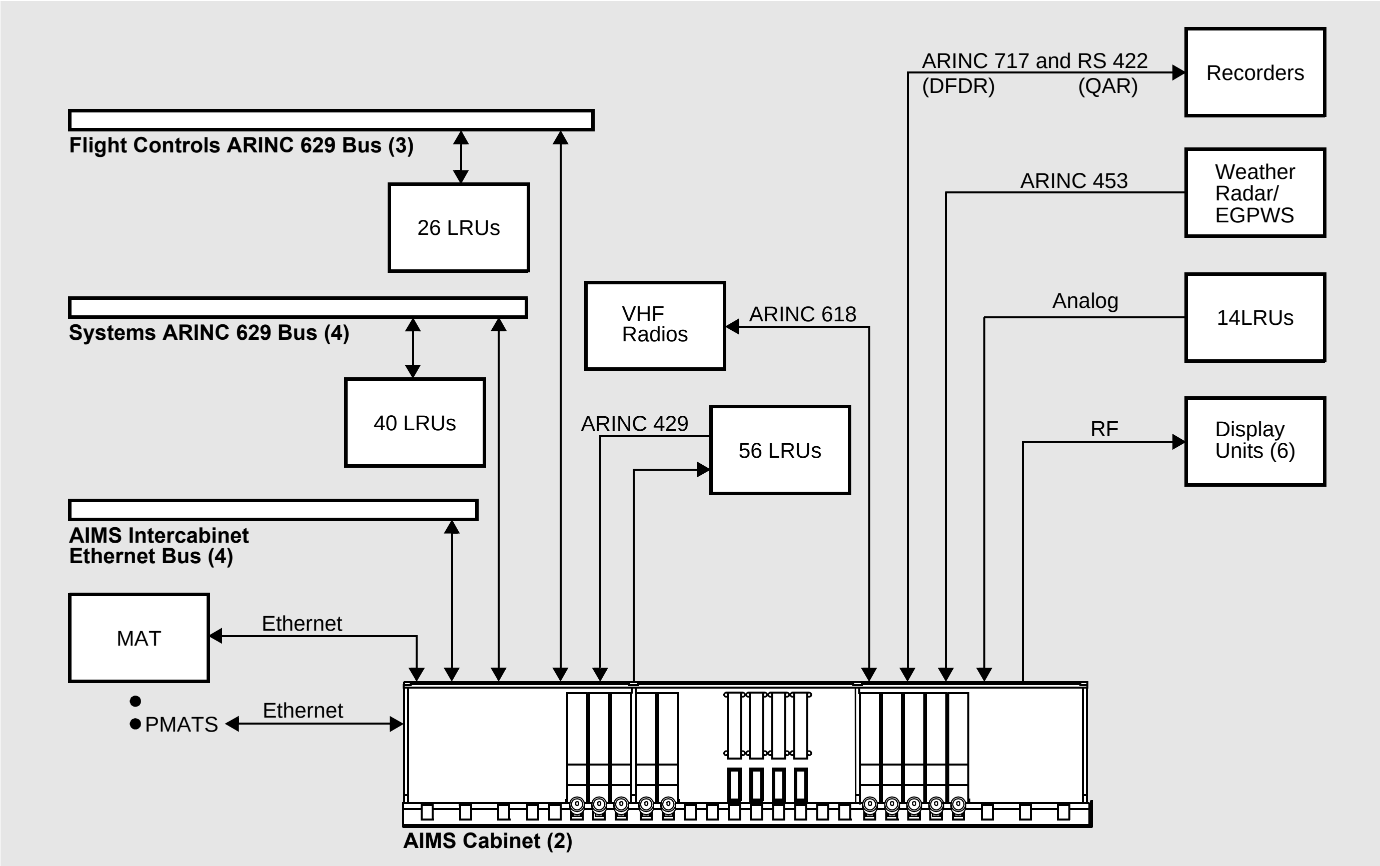
- Primary display system (PDS)
- Flight management computer system (FMCS)
- Thrust management computer system (TMCS)
- Central maintenance computer system (CMCS)
- Airplane condition monitoring system (ACMS)
- Data communication management system (DCMS)
- Flight data recorder system (FDRS).

These are the functions that the LRMs in the AIMS cabinet calculate:

- PDF
- FMCF
- TMCF
- CMCF
- ACMF
- QARF
- DCMF
- FDCF
- DFDAF.

The LRMs also do other functions to change data between non-ARINC 629 and ARINC 629 data.

Airplane Information Management System



Airplane Information Management System Interfaces

AIMS Interfaces

The AIMS has interfaces with many airplane systems with different types of data formats. These are the data formats that AIMS uses:

- ARINC 629
- ARINC 429
- ARINC 618
- ARINC 453
- ARINC 717
- RS 422
- Analog
- Radio frequency (RF).

There are different isolated ARINC 629 buses in relation to the type of data and the redundancy requirements. The flight controls buses have flight critical data necessary for the primary flight control system and the autopilot flight director system. The systems buses give data to and receive data from many other systems for system operation and for display. The AIMS intercabinet buses have data that the AIMS cabinets give to each other and the CDUs.

The data used for downlink on the VHF communication system is ARINC 618.

Many systems transmit and receive ARINC 429 data.

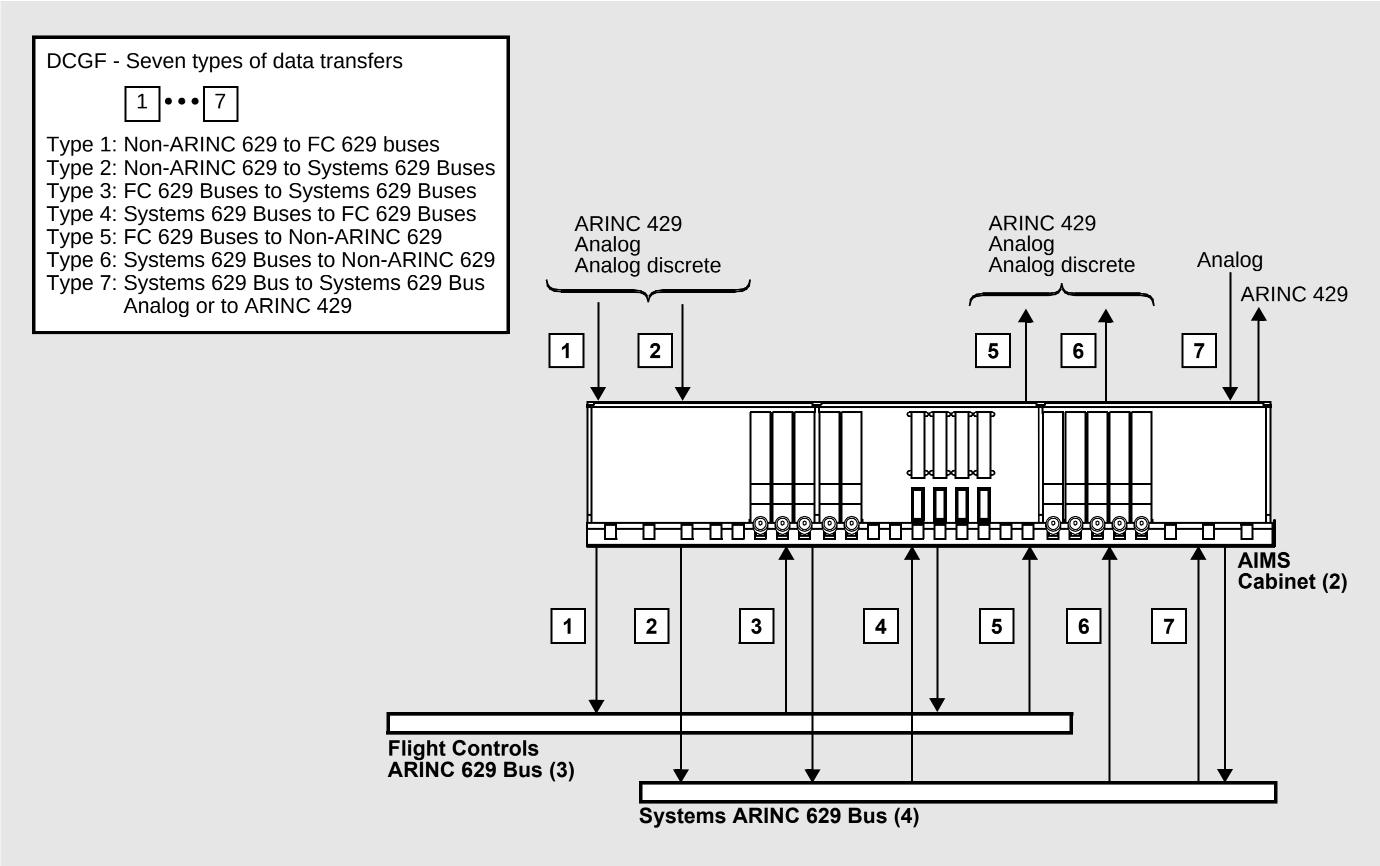
The weather radar system and enhanced ground proximity warning system use ARINC 453.

The flight data recorder and quick access recorder use ARINC 717 and RS 422 data.

The AIMS cabinets receive discrete switch data and some engine sensor data with analog interfaces.

The display units receive an RF signal from the AIMS cabinets.

The interface between the AIMS cabinets and the MAT and the portable MATs is with an Ethernet connection.



Data Conversion Gateway Function

Data Conversion Gateway Function

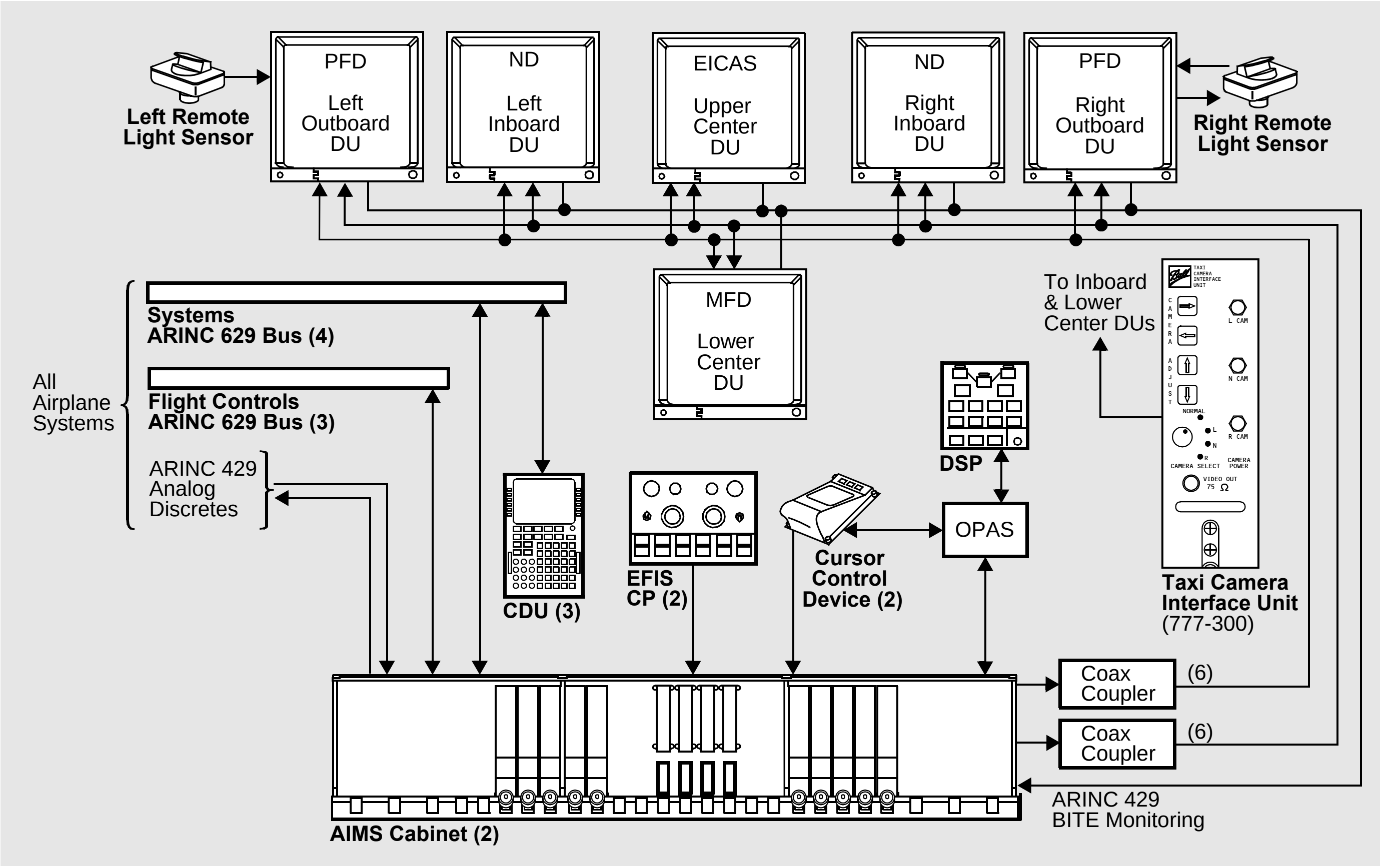
The data conversion gateway function (DCGF) moves data between:

- Buses and analog discrete signals
- Buses and analog signals
- Buses of different formats
- Buses of the same format.

The DCGF supplies seven types of data conversions and transfers. These are:

- Type 1 - receive ARINC 429 data, analog signals, and analog discrete signals and transmit this data to the flight controls (FC) ARINC 629 buses
- Type 2 - receive ARINC 429 data, analog signals, and analog discrete signals and transmit this data to the systems ARINC 629 buses
- Type 3 - receive data from the FC ARINC 629 buses and transmit this data to the systems ARINC 629 buses
- Type 4 - receive data from the systems ARINC 629 buses and transmit this data to the FC ARINC 629 buses
- Type 5 - receive data from the FC ARINC 629 buses and transmit ARINC 429 data, analog signals, and analog discrete signals
- Type 6 - receive data from the systems ARINC 629 buses and transmit ARINC 429 data, analog signals, and analog discrete signals
- Type 7 - data transfers between same types of buses and data transfers between analog and ARINC 429 buses.

For systems with higher levels of importance, like engine data, the DCGF supplies redundant and isolated paths for the data.



Primary Display System

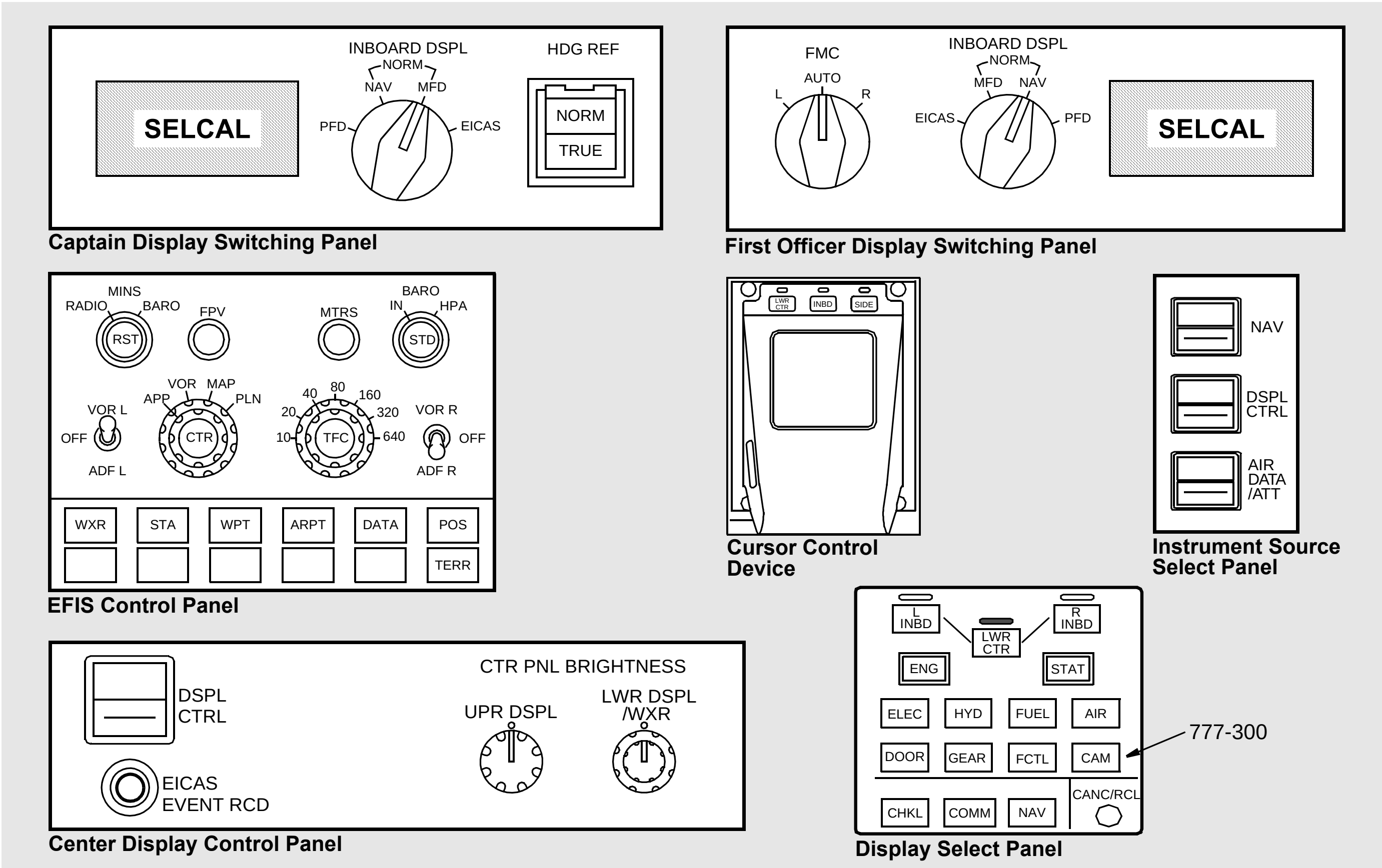
Primary Display System

The primary display system shows data on six flat panel liquid crystal display (LCD) display units (DUs). The DUs show these four types of displays:

- Primary flight display (PFD)
- Navigation display (ND)
- EICAS
- Multi-function display (MFD) that includes the secondary engine, status, synoptic, maintenance page, electronic checklist, and flight deck communication function (FDCF) formats.

These are the components of the display systems:

- Primary display function in the AIMS cabinets
- LCD display units (6)
- Remote light sensors (2)
- Electronic flight instrument system (EFIS) control panels (2)
- Cursor control devices (2)
- Display select panel
- Coax couplers (4)
- Center display control panel (not shown)
- Display switching panels (not shown) (2)
- Instrument source select panels (not shown) (2).



Display Control Panels

Display Control Panels

The display system has these control panels:

- General controls
- EFIS controls
- EICAS controls.

The general controls include:

- The captain and first officer display switching panels to select the display format on the inboard display units
- The cursor control device to select and activate items on the MFD.

The EFIS controls include:

- The instrument source select panel to select the source of EFIS data
- The EFIS control panel to control the PFD and ND.

The EFIS control panel has these controls for the PFD:

- Barometric altitude reference in inches of mercury or hectopascals
- Radio altitude decision height value or barometric minimums
- Flight path vector on or off
- Altitude reference in feet or in feet and meters.

For the ND, the EFIS control panel selects these functions:

- Display mode format (map, plan, approach, or VOR)
- Range
- VOR and ADF pointers on or off
- Weather radar on or off
- TCAS on or off
- Other navigation data.

The EICAS controls include:

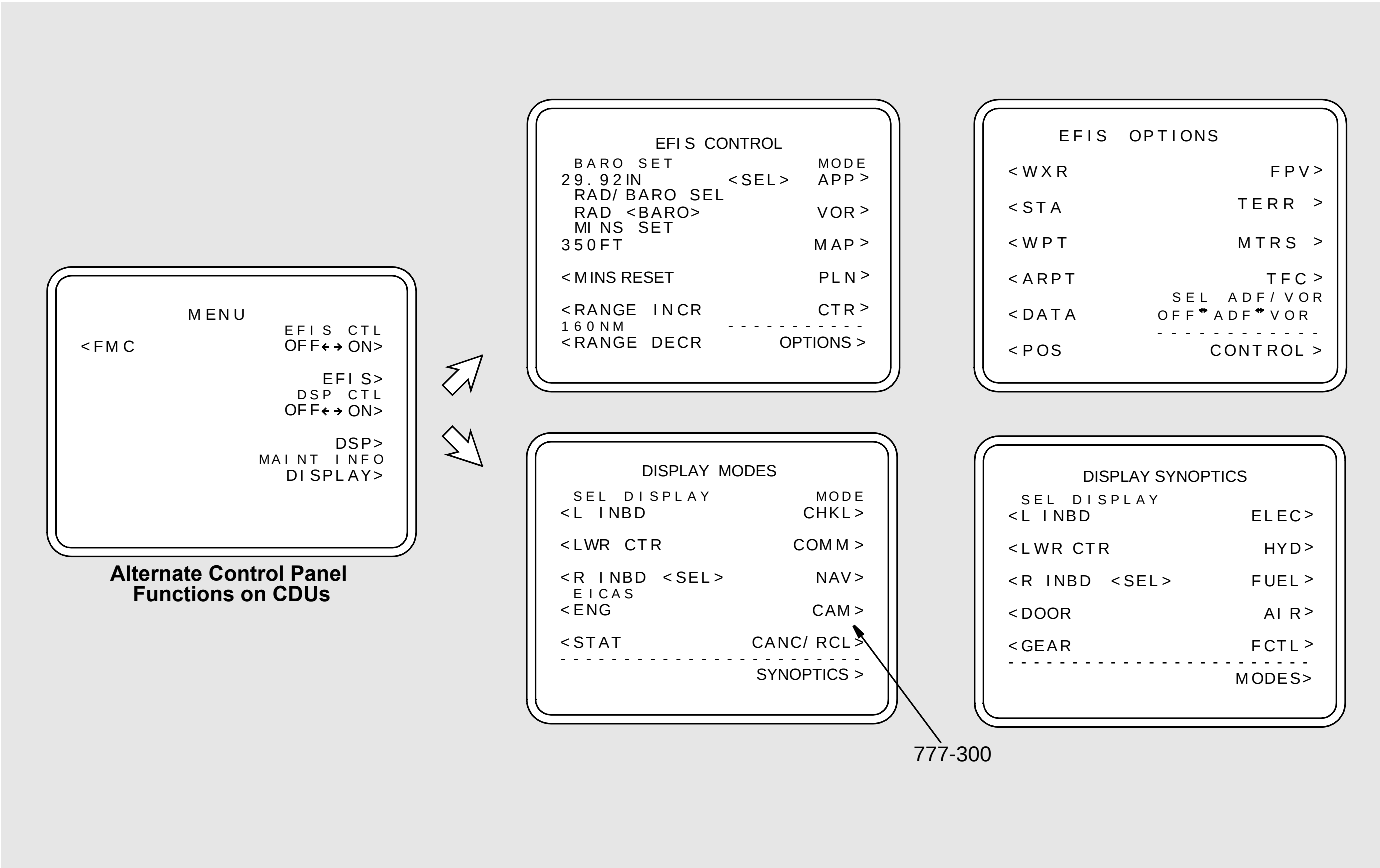
- The center display control panel to control the display source and event recording
- The display select panel to control the EICAS and MFD formats.

On the EICAS display, the display select panel does these functions:

- Scrolls through message field
- Shows compacted format in a limited mode.

On the MFD format, the display select panel does these functions:

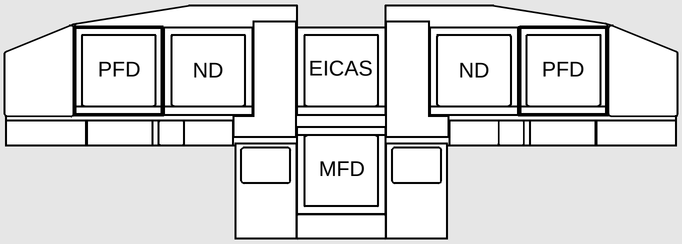
- Selects display format
- Scrolls the status message field.

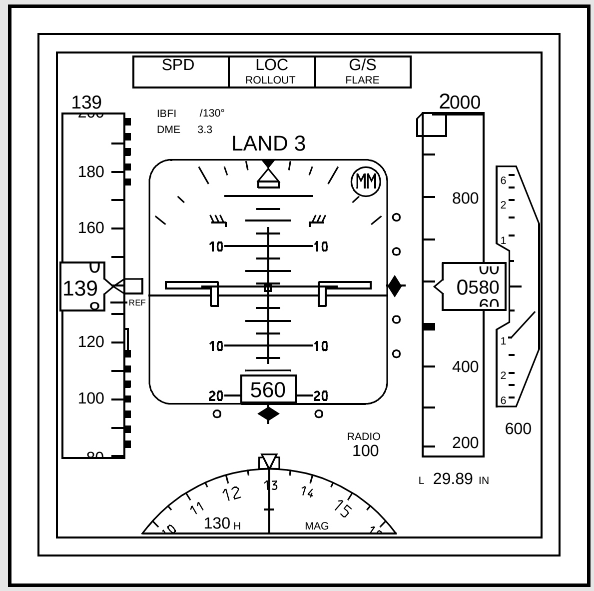


Alternate Control Panels

Alternate Control Panels

The left and right CDUs operate as alternate EFIS control panels. Any CDU can operate as an alternate display select panel. The flight crew selects this alternate function from the CDU main menu. The left CDU operates as the left EFIS control panel, the right CDU operates as the right EFIS control panel. The center CDU is a backup for the left or right CDU.





Primary Flight Display

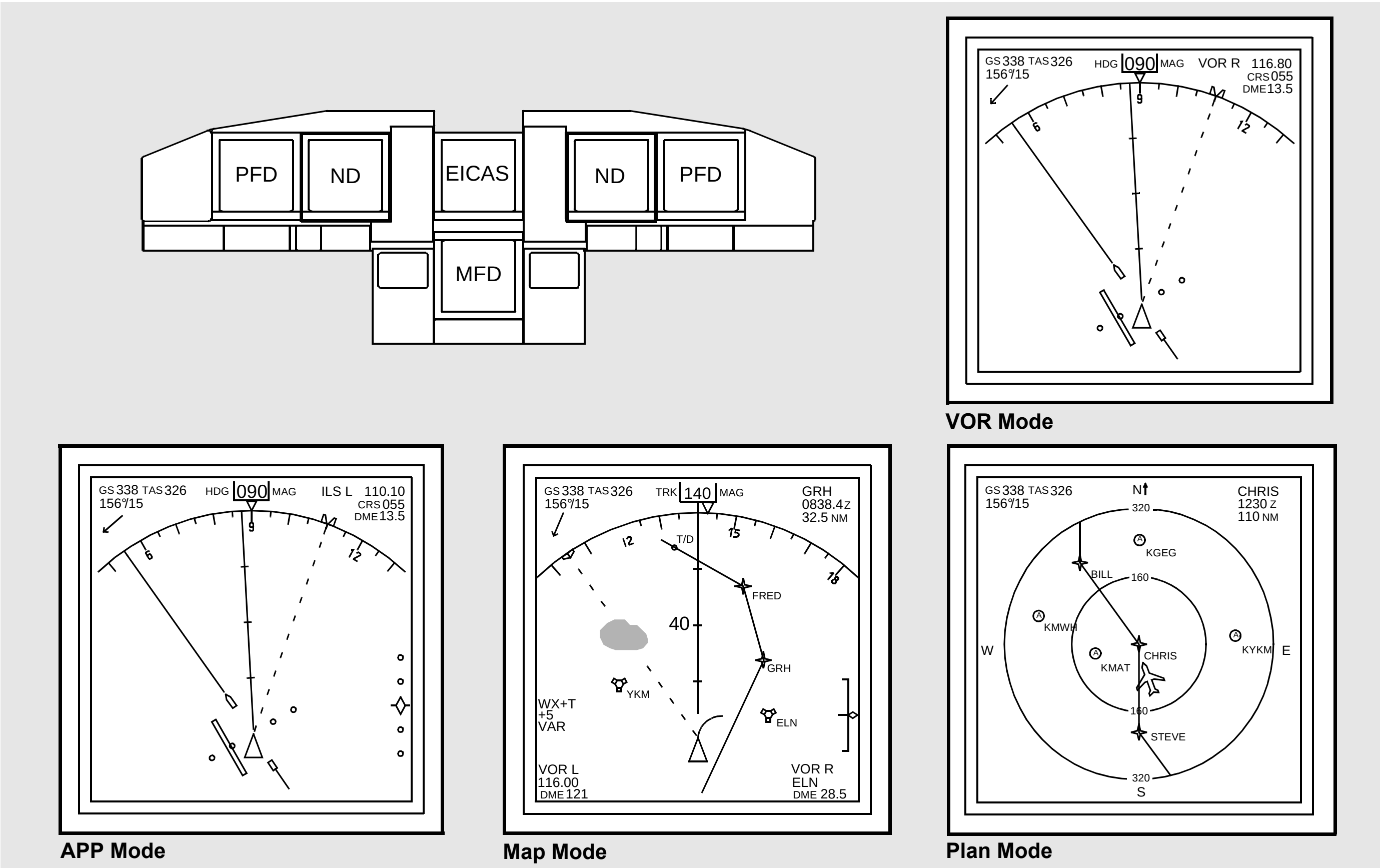
Primary Flight Display

Primary Flight Display

The captain and first officer have a primary flight display (PFD). The PFD normally shows on the outboard display units. The PFD can also show on the inboard display units. The PFD integrates, on a single format, the primary state of the airplane as well as autoflight, flight management, and thrust management command information.

The PFD shows this information:

- Attitude
- Airspeed
- Barometric altitude
- Vertical speed
- Heading
- Flight modes
- Radio altitude
- ILS data
- TCAS resolution advisory
- Time critical warning (TCW).



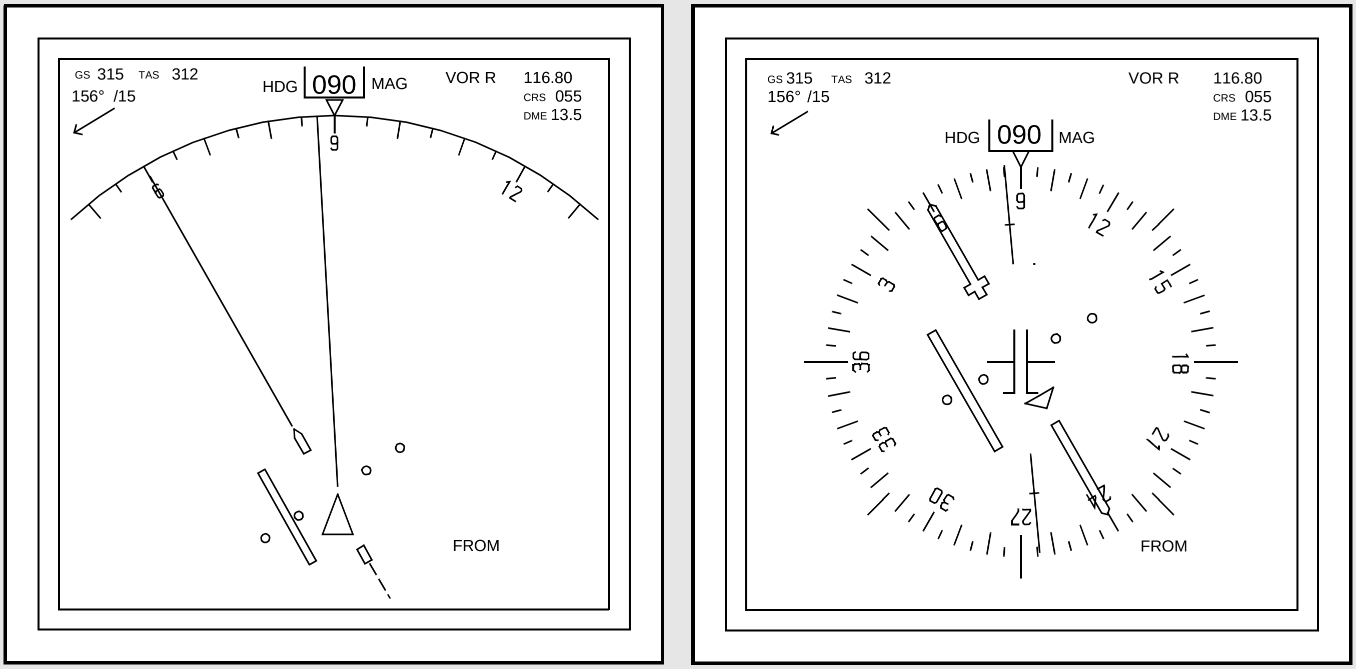
Navigation Display

Navigation Display

The captain and first officer each have a navigation display (ND). The ND normally shows on the inboard display units. An ND can also show on the lower center DU. The ND provides flight and navigation information in one of several formats.

The ND shows these four display modes:

- VOR
- APP (approach)
- Map
- Plan.



Expanded VOR Mode **Centered VOR Mode**

Navigation Display - VOR Mode

VOR Mode

The VOR mode shows in a centered or expanded display format.

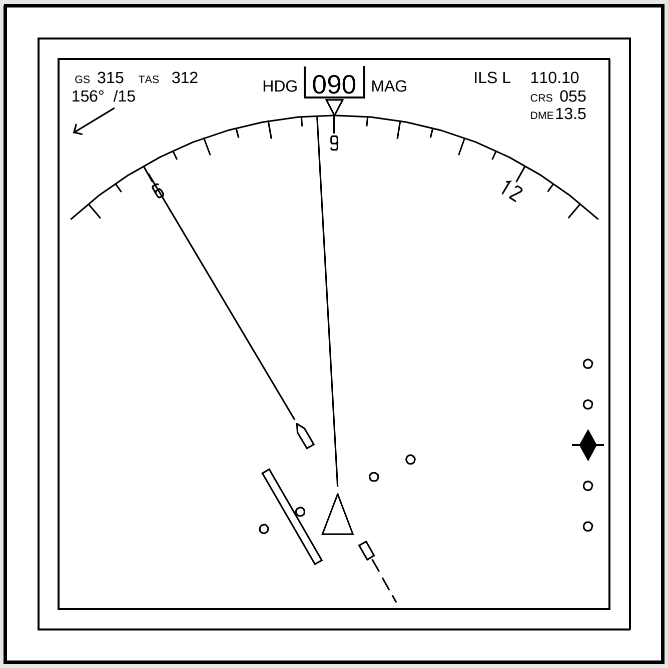
The centered VOR mode shows 360 degrees of the compass rose with the airplane symbol and lateral deviation bar in the center. The expanded VOR mode shows 80 degrees of the compass rose with the airplane symbol and the deviation bar at the bottom.

The VOR mode shows this information:

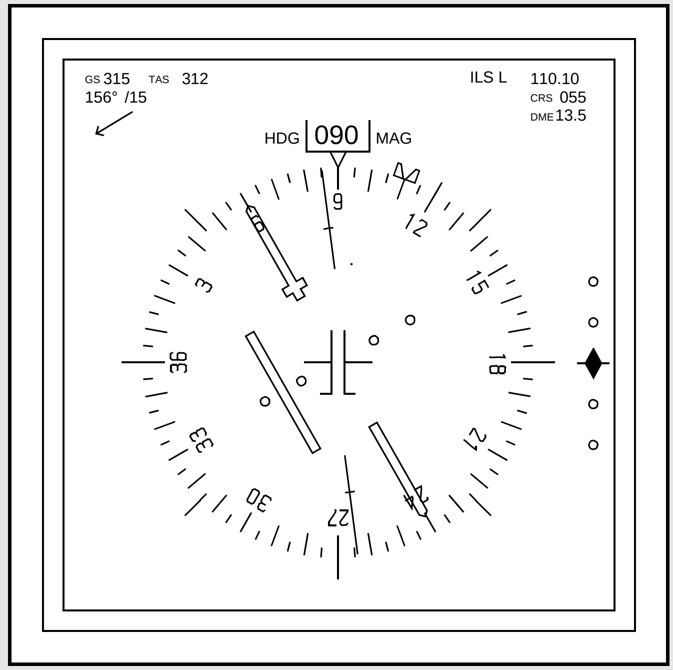
- System source annunciation
- VOR deviation
- TO/FROM annunciation
- Station identification and frequency
- Station bearing
- Selected course
- DME distance
- TCAS data
- Weather radar (expanded only).

The VOR deviation shows only when the flight crew tunes the VOR manually. Both displays are heading up displays.

Additional VOR data shows in the lower corners of the display. Select VOR on the EFIS control panel to show bearing pointers on the compass rose.



Expanded Approach Mode



Centered Approach Mode

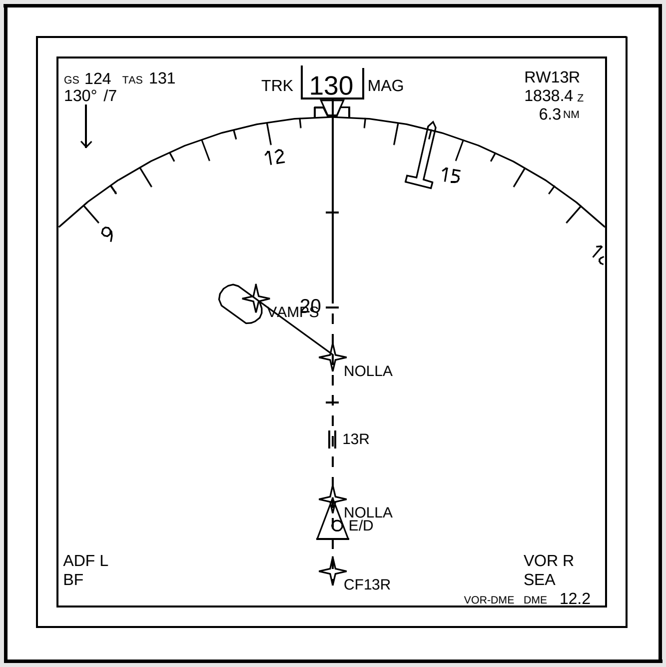
Navigation Display - Approach Mode

Approach Mode

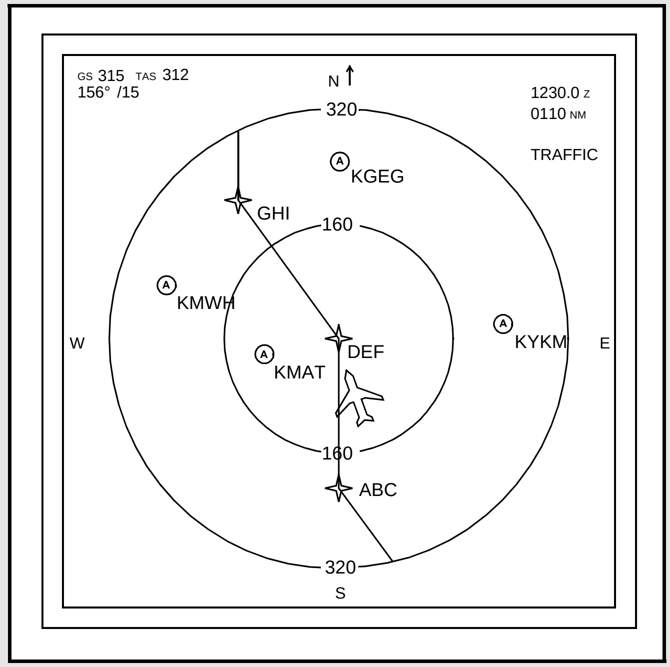
The APPROACH mode shows as an expanded or centered display. The centered APPROACH mode shows 360 degrees of the compass rose with the airplane symbol and lateral deviation bar in the center. The expanded APPROACH mode shows 80 degrees of the compass rose with the airplane symbol and the deviation bar at the bottom. Glideslope deviation shows on the side of the display. Both displays are heading up displays.

The approach mode show this information:

- System source annunciation
- Localizer deviation
- Glideslope deviation
- Station identifier and frequency
- Selected runway heading
- DME distance
- TCAS data
- Weather radar (expanded only).



Expanded Map Mode



Plan Mode

Navigation Display - Map Mode and Plan Mode

Map Mode

The map mode shows the part of the flight plan in the selected range. The range is up to 640 NM. The map mode shows as an expanded or centered display. The centered MAP mode shows 360 degrees of the compass rose with the airplane symbol in the center. The expanded MAP mode shows 80 degrees of the compass rose with the airplane symbol at the bottom. The displays can be track up or heading up.

The map mode shows this data:

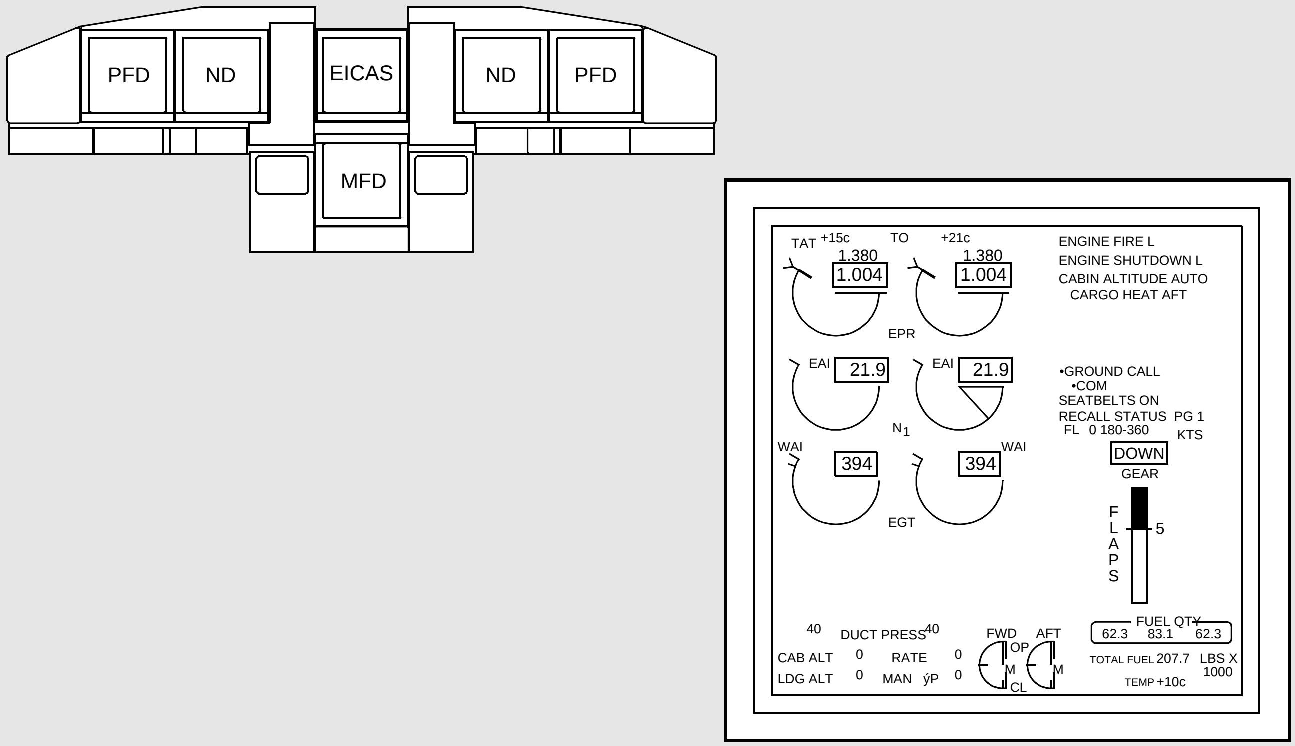
- FMC route
- Active waypoints
- Distance to go
- Estimated time of arrival (ETA)
- Vertical deviation
- Lateral deviation
- Trend vector
- Tuned NAVAIDS
- Weather radar
- FMCS NAV data
- TCAS traffic.

Plan Mode

The flight crew uses the plan mode to make, see, or change a flight plan. The display is a north up display. The airplane symbol shows present position and FMC track.

This plan mode shows this data:

- FMCS route
- TCAS data.



EICAS Display

EICAS Display

EICAS Display

The engine indication and crew alerting system (EICAS) display normally shows on the upper center display unit. It can also show on the lower center DU or the inboard DUs.

The EICAS display shows this data:

- Engine pressure ratio (EPR)
- N1 rotor speed
- Exhaust gas temperature (EGT)
- Total air temperature (TAT)
- Thrust mode
- Selected temperature for derate
- ECS duct pressure
- Cabin altitude and rate of change
- Landing altitude
- Cabin differential pressure
- Crew alert messages
- Status Alert
- In-flight start information
- Landing gear position
- Flap/slat position
- Total fuel quantity (lbs or kg)
- Fuel temperature.

The crew alerting part of the EICAS monitors airplane systems. If a fault occurs, EICAS shows a crew alerting message on the upper center display unit. As well as the messages, some crew alerts have aural tones, and the master warning or caution lights come on.

Messages are in one of these groups:

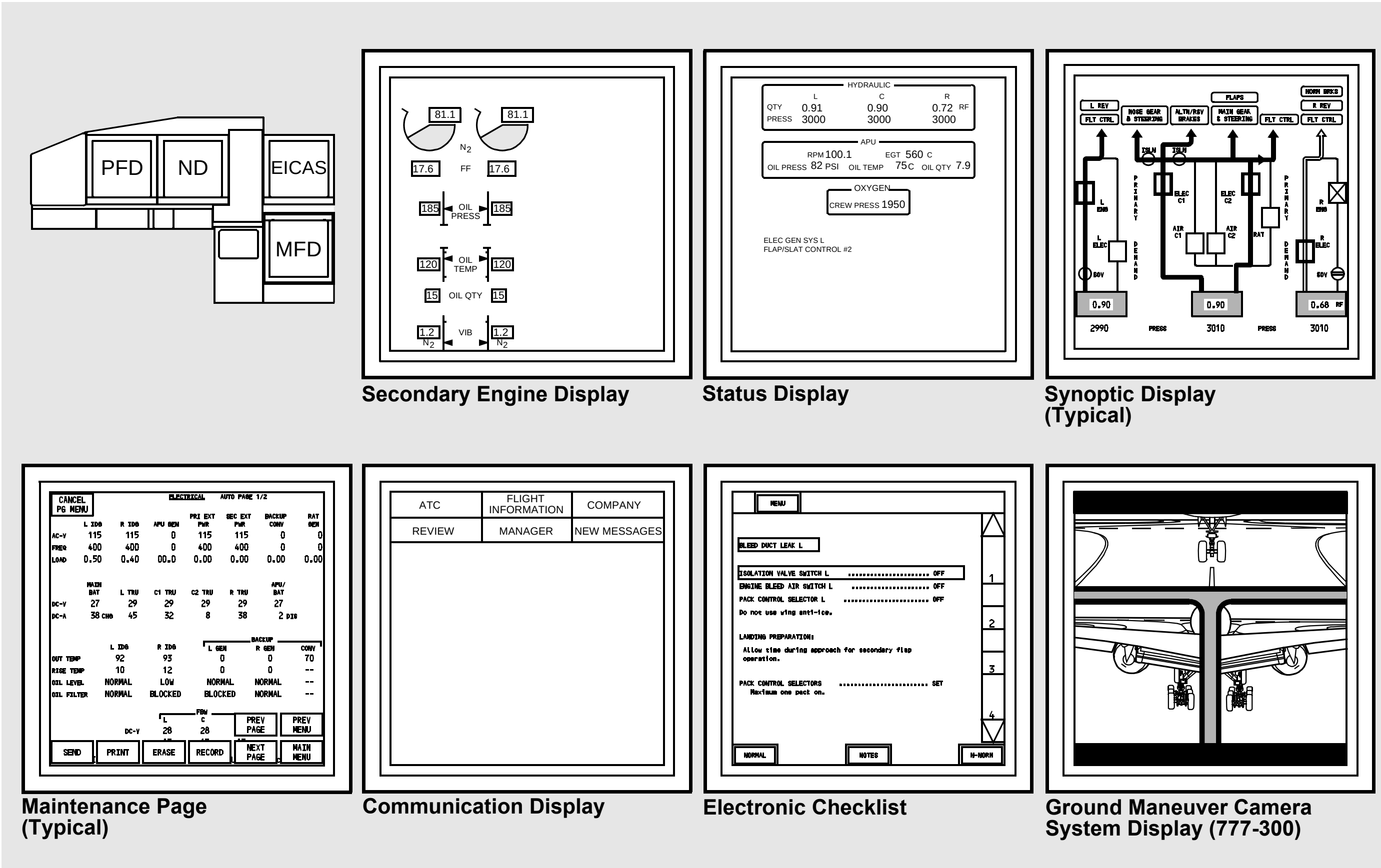
- Warnings
- Cautions
- Advisories
- Communications
- Memos.

Messages show on the display in the order of importance and occurrence. Warnings show in red at the top of the message field. Cautions show in amber below warning messages.

Advisories show in amber below caution messages. Advisories have a one-space indent. Communication and memo messages are white. A bullet (•) shows before each communication message.

Different aurals come on with warning and caution level alerts. Warning aurals can be a bell, a voice, or a siren. All caution aurals are a beeper that comes on four times in one second and stops. Some communication messages have a chime. All aurals stop automatically when the alert condition stops.

The master warning or caution lights come on for a warning or caution alert. The lights stay on for the time of the warning or caution. Push one of the switch/lights to put off and set the two lights for future alerts.



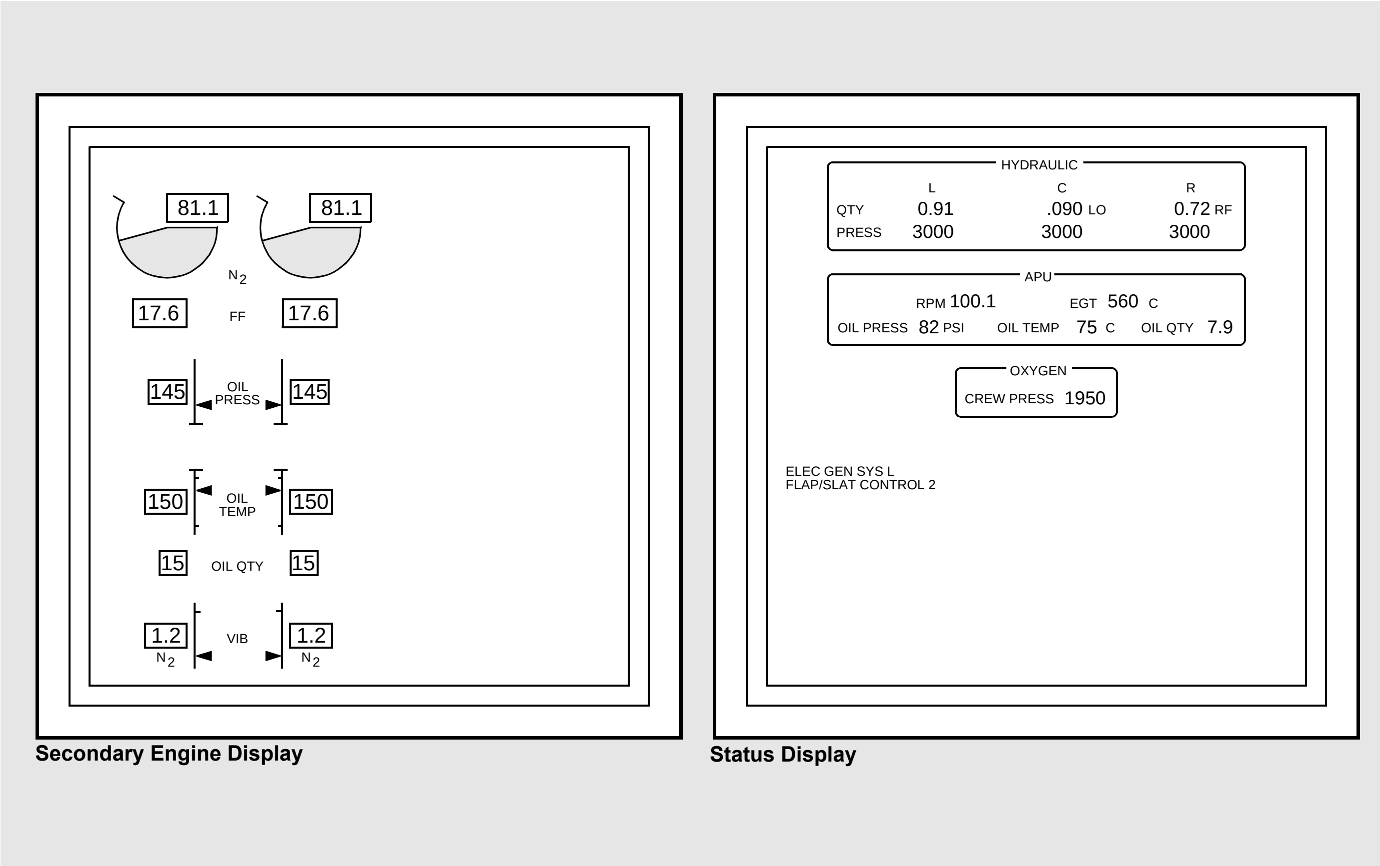
Multi-Function Display

Multi-Function Display

The multi-function display (MFD) format normally shows on the lower center display unit. The format can also show on the inboard display units. The MFD format shows auxiliary information to the flight crew and maintenance crew.

These are the MFD formats:

- Secondary engine display
- Status display
- Synoptic display
- Maintenance page
- Communication display
- Electronic checklist
- Ground maneuver camera system display (777-300).



MFD Formats

Secondary Engine Display

The secondary engine display shows automatically at power up. The format also shows when the flight crew selects the ENG switch on the display select panel.

The secondary engine display shows this information:

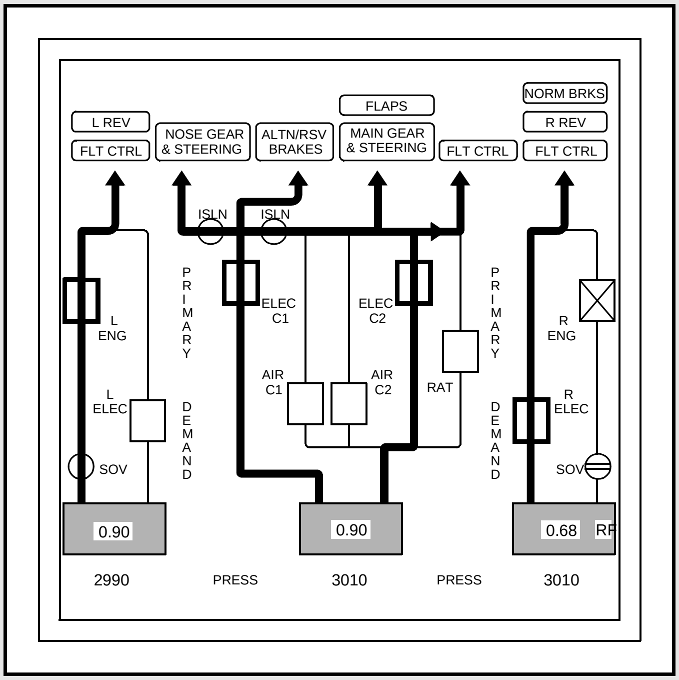
- N2 rotor speed
- Fuel flow
- Oil pressure, temperature, and quantity
- Engine vibration.

Status Display

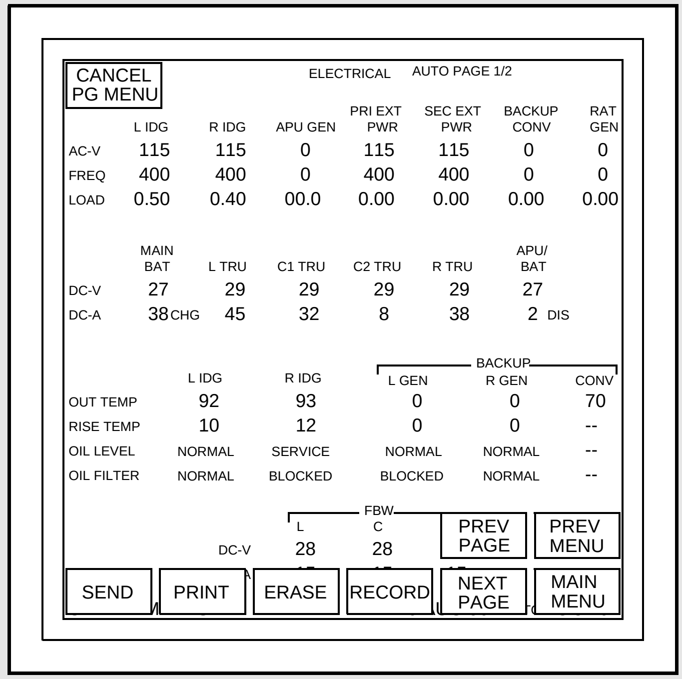
The status display shows on the MFD when the flight crew selects the STAT switch on the display select panel.

The status display shows this information:

- Hydraulic quantity
- Hydraulic pressure
- APU EGT
- APU rotor speed
- APU oil quantity
- Crew oxygen pressure
- Status messages.



Synoptic Display (Typical)



Maintenance Page (Typical)

MFD Formats

Synoptic Display

The synoptic display shows a picture of systems status.These are the systems that have synoptic displays:

- Electrical
- Fuel
- Air (environmental control)
- Flight control
- Hydraulic
- Doors
- Landing gear.

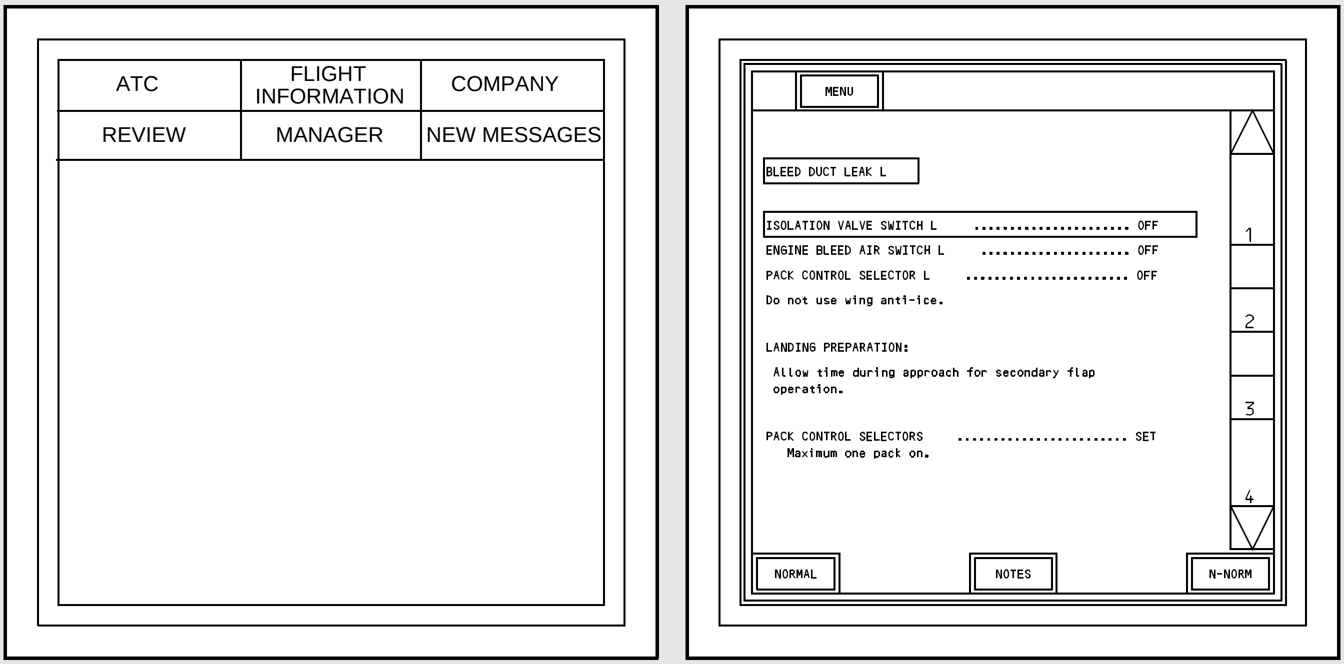
Maintenance Page

Initial access to maintenance pages is through a prompt on the CDUs. The cursor control devices give other controls.

The maintenance page shows airplane system data for use by maintenance crews. The data helps in troubleshooting and repair of airplane systems. A maintenance page records automatically when an exceedance occurs for a parameter on that maintenance page. This data is available to the maintenance crew after the end of the flight to help make an analysis of a fault.

These are the maintenance pages available by ATA chapter:

- 21 Air Conditioning
- 24 Electrical
- 26 Fire Protection
- 27 Flight Controls
- 27 Flap/slat
- 28 Fuel Quantity
- 28 Fuel Management
- 29 Hydraulic
- 30 Ice Protection
- 31 Maintenance Task
- 32 Landing Gear Actuation/ Indication
- 32 Landing Gear Brakes/ Steering
- 36 Air Supply
- 49 APU
- 71 Performance
- 71 EPCS
- 71 Propulsion Data Limits
- 71 Engine Exceedance.



Communication Display **Electronic Checklists**

MFD Formats

Communication Display

The communication display provides the crew interface with the data communication management system (DCMS).

Electronic Checklist

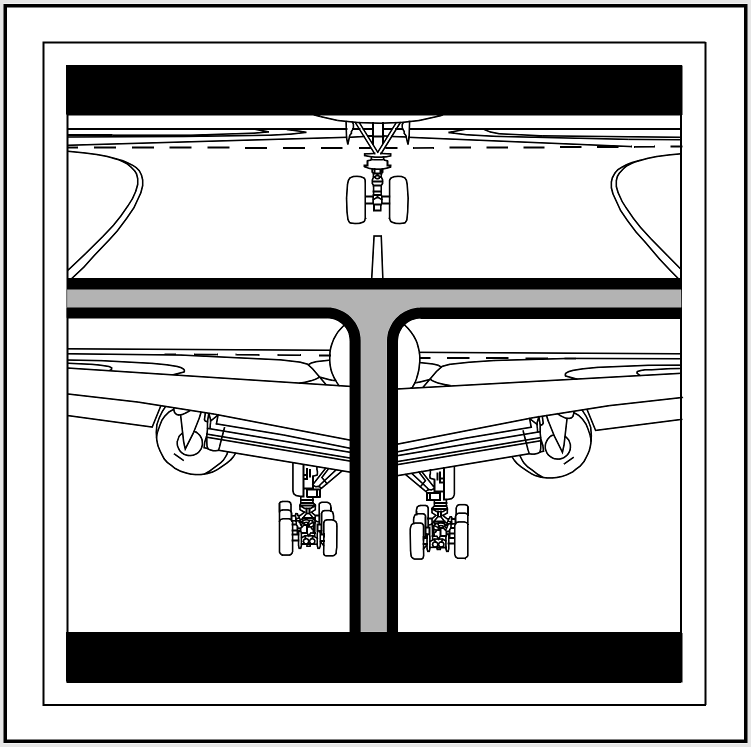
The electronic checklists are available for all the checklists that show in the Operations Manual. These are the checklists available:

- Normal checklists
- Non-normal checklists
- Unannunciated checklists.

Normal checklists show in order for the current flight phase.

Non-normal checklists show in order of critically and time of occurrence. A white box adjacent to an EICAS message shows that there is a related non-normal checklist for that message.

Unannunciated checklists are available for non-normal conditions that do not cause an EICAS message.



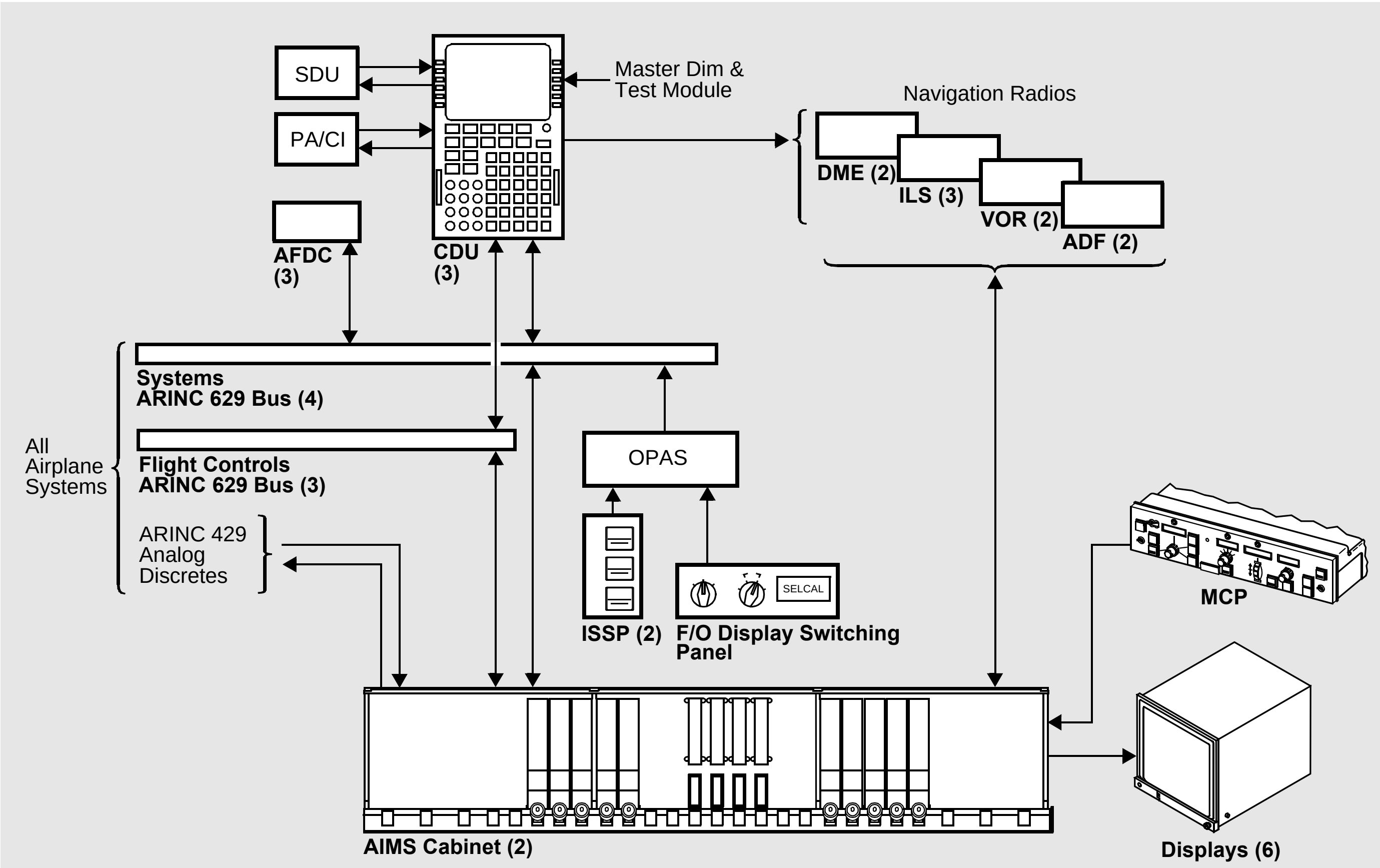
Ground Maneuver Camera System Display
(777-300)

MFD Formats

Ground Maneuver Camera System Display

This display shows the video from three cameras. This display lets the flight crew or the ground taxi crew see the main and nose landing gear from the flight compartment during ground maneuvers of the 777-300 airplane.

This display is a three-view split screen.



Flight Management Computing System

Flight Management Computing System

The flight management computing system (FMCS) decreases flight crew work load. To do this, it gives vertical and lateral guidance for all phases of flight but takeoff and landing. The FMCS also gives navigation data to the flight crew on the forward displays and does an autotune of the navigation radios.

The two AIMS cabinets have the same flight management computing function (FMCF). The active FMCF sends lateral guidance commands and vertical guidance commands to the AFDCS with mode requests from the MCP. The other FMCF operates as a standby.

The primary crew interface for the flight management computing system are the three CDUs. The flight crew puts data in on the left or right CDU. The center CDU operates as a back-up if the left or right CDU has a failure. If the FMCF has a failure, the CDUs can calculate lateral guidance commands and let the crew manually tune on-side radios. The two AIMS cabinets use the data entries. The CDUs have interfaces with other systems for control and display.

The FMCF has these functions:

- Navigation
- Flight planning
- Performance management
- Navigation radio tuning.

The navigation function calculates airplane position and velocity.

The FMCF memory contains a navigation database. This database has data for:

- NAVAID locations
- Waypoints
- Departure/arrival procedures
- Company flight plans.

The flight planning function uses flight crew entries to make the lateral flight plan.

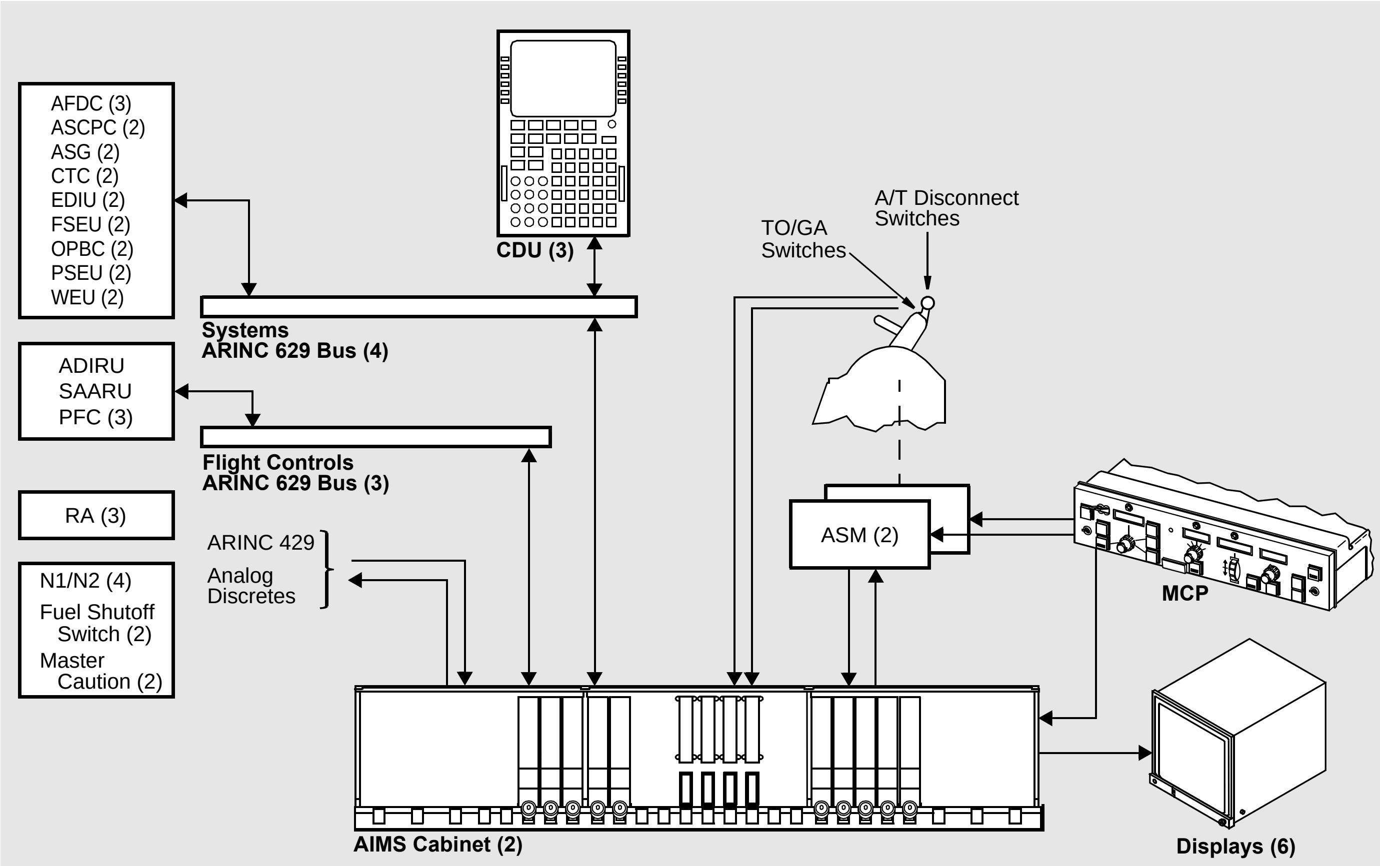
The FMCF performance management function uses the airplane aerodynamic model and flight crew entries to calculate the most economical vertical flight path. The flight crew entries are:

- Cost index
- Cruise altitude
- Airplane gross weight.

The FMCF navigation radio tune function does an autotune of the NAV radios for position and display update.

The GBST gives AMI for:

- FMCF software option code
- Performance factors
- AMI P/N.



Thrust Management Computing System

Thrust Management Computing System

The thrust management computing system (TMCS) moves the thrust levers, gives the thrust limit displays, and shows the autothrottle modes during takeoff and all flight phases. The TMCF also supplies trim commands to the engines.

The two AIMS cabinets have the same thrust management computing function (TMCF). The active TMCF sends autothrottle commands to the autothrottle servo motors (ASMs) and trim commands to the engine electronic controllers (EECs). The other TMCF operates as a standby.

These are the components in the TMCS:

- Thrust management computing function (TMCF) of AIMS
- Autothrottle servo motors (ASM)
- Autothrottle arm and mode switches on the mode control panel (MCP)
- TO/GA switches
- A/T disconnect switches.

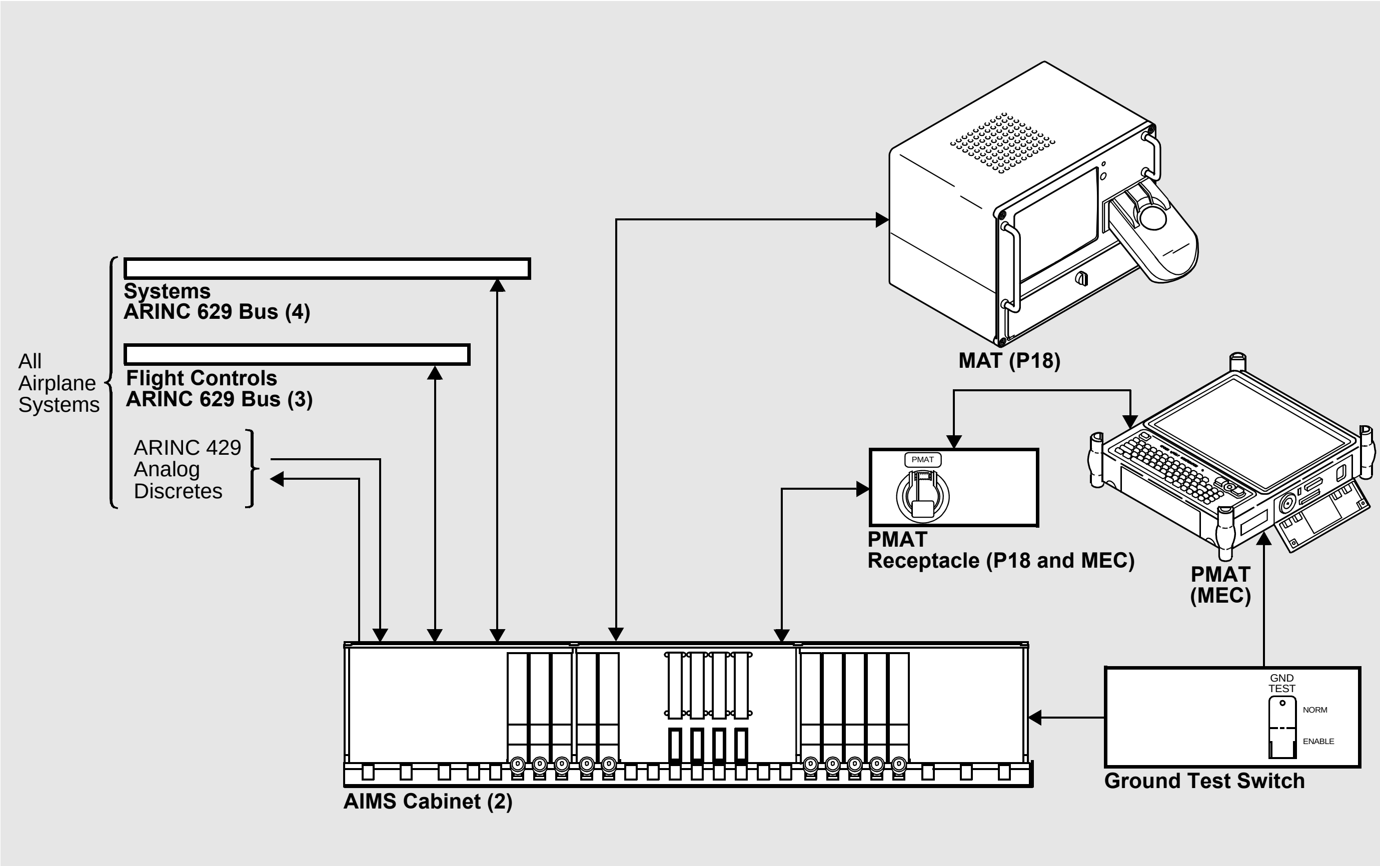
The TMCF has these outputs:

- Autothrottle commands for all flight phases (1 or 2 engines)
- Engine trim equalization commands through the EDIUs to the electronic engine controllers (EECs)
- Thrust limits for display and control
- Autothrottle modes for display.

The TMCF calculates autothrottle commands with crew entries from the flight deck and inputs from the FMCF and external sensors. The TMCF sends thrust lever position commands to the ASMs.

The TMCF calculates and sends engine trim commands through the EDIUs to the EECs. To do this, the TMCF monitors engine thrust differences. This occurs for all phases of flight when the engines are at idle power or above to decrease engine thrust differences.

The TMCF supplies autothrottle modes and calculates thrust limits. These outputs go to the display system. The flight crew selects autothrottle modes from the mode control panel (MCP) and the TO/GA levers. The flight crew selects the thrust limit mode from the thrust limit page on the CDU. Thrust limit mode selection also occurs automatically when the flight management system engages in the vertical navigation mode.



Central Maintenance Computing System

Central Maintenance Computing System

The central maintenance computing system (CMCS) collects, keeps, and shows maintenance data for most of the airplane systems. You use the CMCS for fault isolation and test.

These are the components of the CMCS:

- Central maintenance computing function (CMCF) in the AIMS cabinets
- Ground test switch
- Side display (2) (optional)
- MAT and its keyboard
- PMAT receptacles (5)
- PMAT.

The crew uses a maintenance access terminal (MAT) in the flight compartment or a portable MAT (PMAT) in the main equipment center to operate the central maintenance computing system.

There is a second PMAT receptacle in the flight compartment on the P18 panel adjacent to the MAT.

The MAT and PMAT connect with the CMCF in the AIMS cabinet through Ethernet connections.

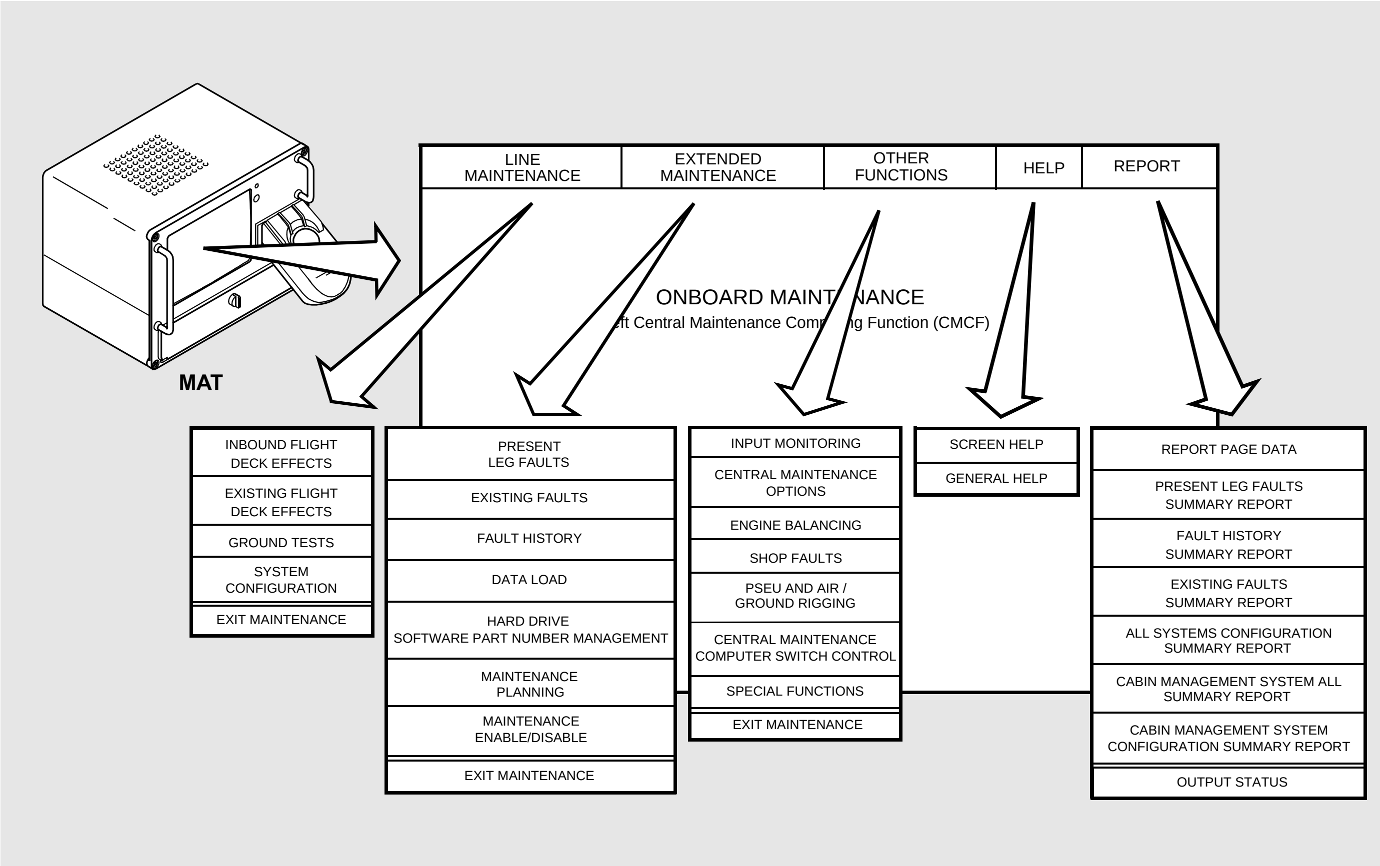
There is a CMCF in each AIMS cabinet. Only one CMCF operates at a time. The other CMCF is a backup.

The CMCF gets fault reports from systems and stores this data in fault history. When the primary display system shows a flight deck effect, the CMCF does a correlation of the fault with a maintenance message. This maintenance message shows what LRU had a failure.

The CMCS also permits ground tests on many systems from the MAT or a PMAT. The CMCS also does the data load gateway function that permits software to load from a diskette in the MAT to an LRU that must have a software load.

These are the other functions of the CMCS:

- LRU software load
- Input monitoring
- Configuration report
- Access to LRU shop faults
- Onboard engine balance
- PSEU and air/ground rig
- Report capabilities.



Maintenance Access Terminal

Maintenance Access Terminal

The maintenance crew uses the maintenance access terminal (MAT) to operate the central maintenance computing system.

The MAT includes a:

- Cabinet
- Display module
- Cursor control device
- Keyboard
- Disk drive module.

The crew selects items on a menu with a cursor control device. The maintenance crew can also use the keyboard to key in data.

The five main menu selections are:

- LINE MAINTENANCE
- EXTENDED MAINTENANCE
- OTHER FUNCTIONS
- HELP
- REPORT.

The LINE MAINTENANCE menu supplies access to these:

- Inbound and existing flight deck effects, and their correlated faults
- Airplane systems tests
- Configuration information.

The EXTENDED MAINTENANCE menu supplies access to these:

- Present leg faults, existing faults, and historical faults
- Data load procedures
- Maintenance memos
- Maintenance enable/disable of the flight leg and the maintenance phase.

The OTHER FUNCTIONS menu supplies access to these:

- Input monitoring
- CMCF options activation/deactivation
- LRU shop faults
- Engine balancing information and procedures
- PSEU and air/ground rigging procedures
- Central maintenance source switching.

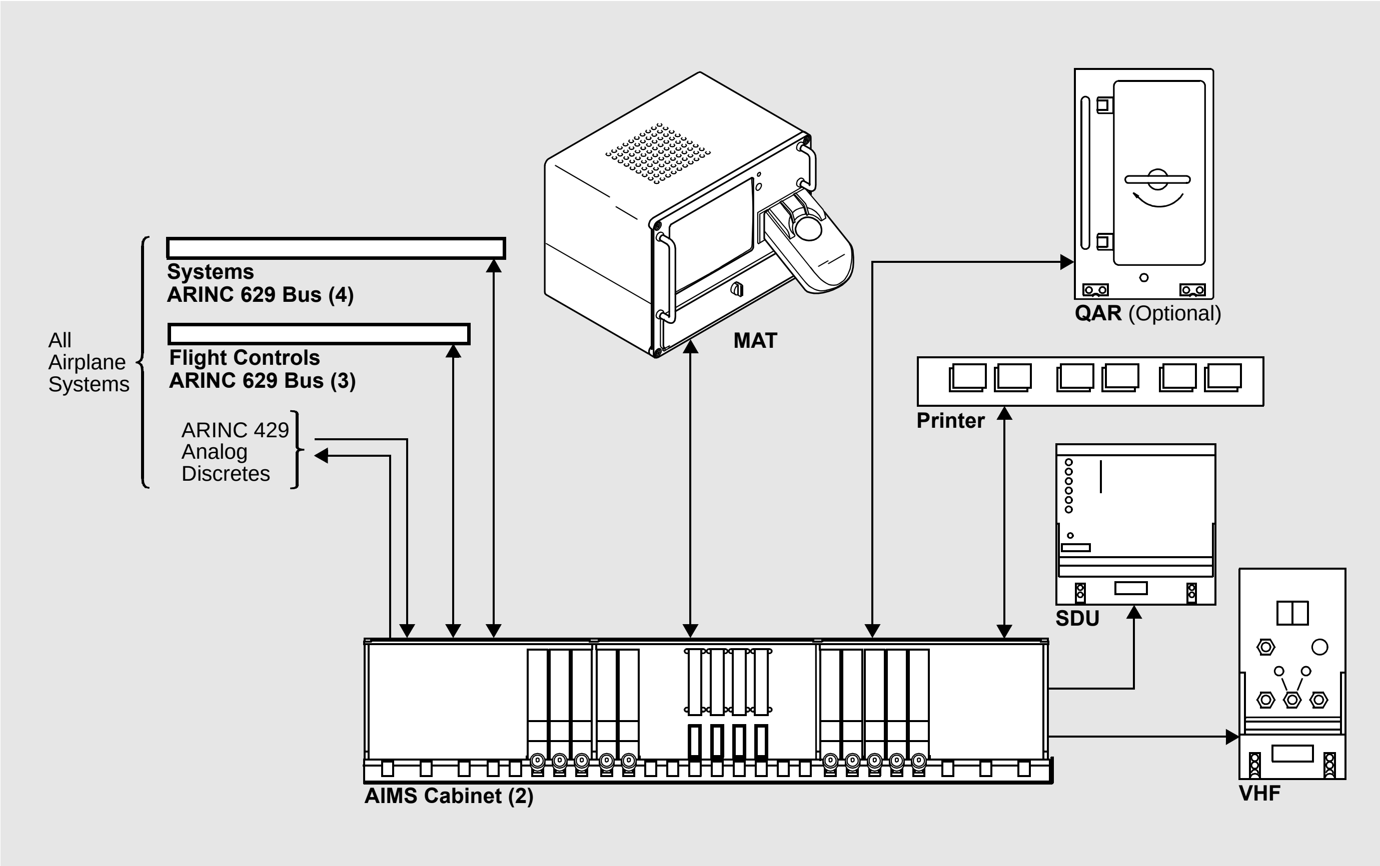
The HELP menu supplies access to help for the MAT and for each function.

The REPORT menu supplies access to reports. The crew can send the report to the flight deck printer, MAT disk drive, or a ground station.

The PMAT has the same menu structure as the MAT.

The GBST provides AMI for:

- Notes for specific information
- Help pages for general information
- Automatic downlink table to define data reports
- Airplane identification cross reference table.



Airplane Condition Monitoring System

Airplane Condition Monitoring System

The airplane condition monitoring system (ACMS) monitors, records, and give reports for selected airplane data such as:

- Maintenance data
- Performance data
- Troubleshooting data
- Trend monitoring.

These are the components of the ACMS:

- Airplane condition monitoring function (ACMF) of AIMS
- Quick access recorder function (QARF) of AIMS
- Quick access recorder.

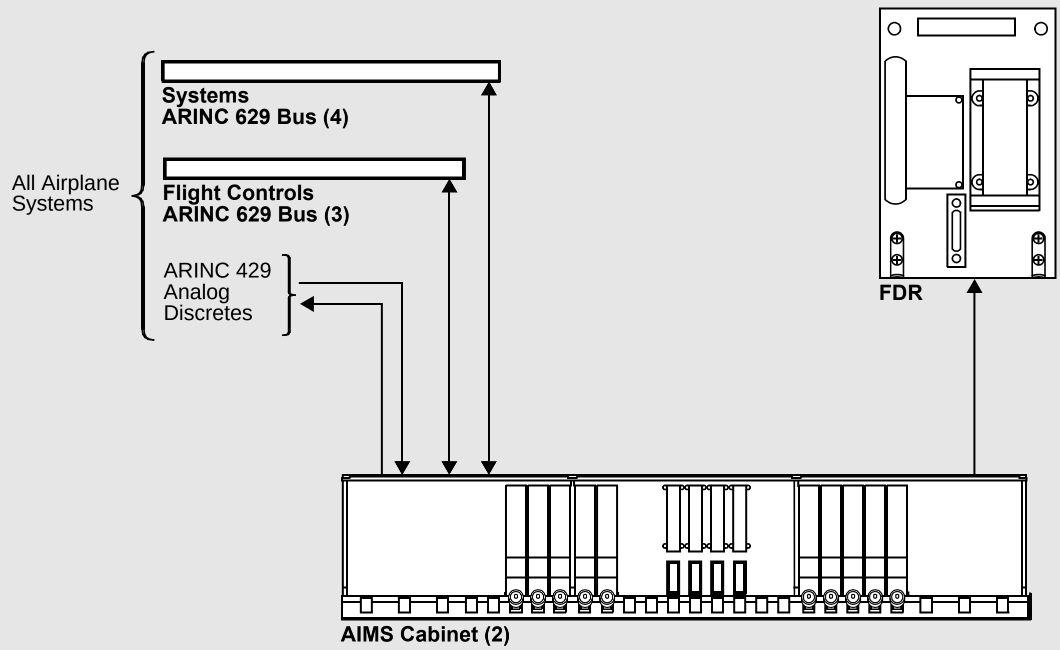
The ACMF software function is in the left AIMS cabinet only.

The airlines can use the ground based software tool (GBST) to set the report format, content, logic, and destination. The destination of a report can be one of these:

- Quick access recorder
- Printer
- Diskette in disk drive
- Ground station through the data communication management function.

The quick access recorder (QAR) is an optional unit. The QAR records data from the ACMF to an optical cartridge.

The software for the quick access recorder operates in the left AIMS cabinet only.



Flight Data Recorder System

Flight Data Recorder System

The flight data recorder system (FDRS) records mandatory and optional flight data for the most recent 25 hours of operation. These are the components of the FDRS:

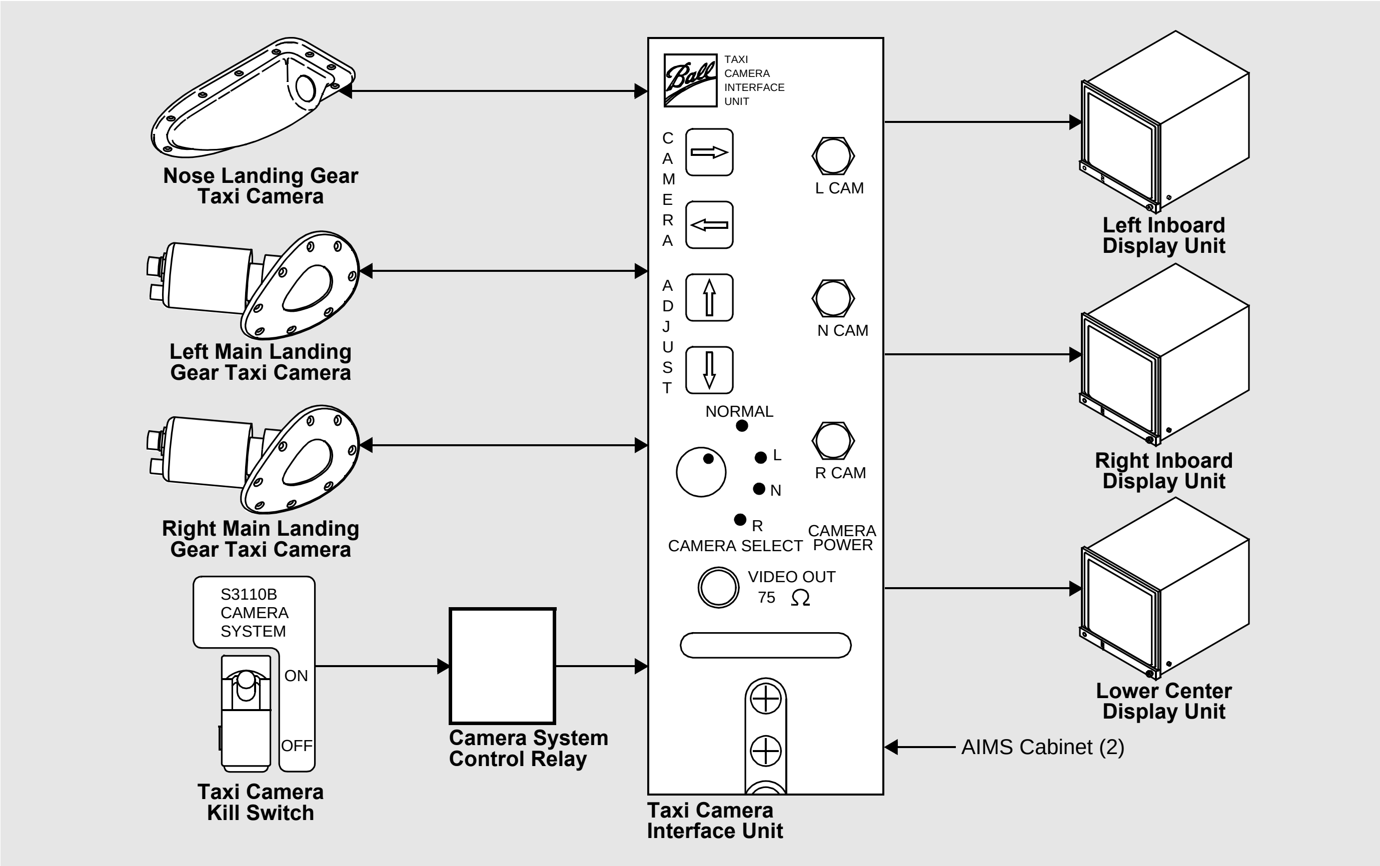
- Digital flight data acquisition function (DFDAF) in the AIMS cabinet
- Flight data recorder (FDR).

The DFDAF in the AIMS collects and does a format of the data and sends it to the FDR. The DFDAF receives data in ARINC 429, ARINC 629, analog, and discrete formats. The DFDAF changes this data into one digital format to send to the FDR.

There is no dedicated FDRS accelerometer on the airplane. The ADIRU supplies longitudinal, lateral, and vertical accelerations. The FDR records these accelerations.

The FDR records the data in a fire and crash resistant LRU. The FDR operates when at least one of the engines are on, or the airplane is in the air.

The DFDAF also monitors FDR faults. The DFDAF sends these faults to the central maintenance computing function and the primary display systems function.



Ground Maneuver Camera System (777-300)

Ground Maneuver Camera System (777-300)

Because of the size of the 777-300 airplane, the ground maneuver camera system (GMCS) helps the flight crew or taxi crew maneuver the airplane on the ground. The system has these three cameras:

- Nose landing gear taxi camera
- Left main landing gear taxi camera
- Right main landing gear taxi camera.

The nose landing gear camera is on the bottom of the airplane. It gives a view of the nose landing gear and the ground in front of the airplane.

The main landing gear cameras are in the leading edge of the left and right horizontal stabilizer. They give a view of the landing gear, engine, and the ground on each side of the airplane.

The taxi camera kill switch is on the P56 main wheel well electrical service panel on the bottom of the airplane in the aft part of the wing-to-body fairing. This switch gives the ground crew the capability to turn off the camera system.

The taxi camera interface unit sends the three-view split screen video directly to the three display units that can show an MFD.

The primary display function in the AIMS gives the display unit(s) the command to show the GMCS video when the crew member pushes the camera (CAM) switch on the display select panel.

Data Communication Management System

The data communication management system (DCMS) supplies these three functions:

- Printer driver control
- Ethernet interface
- ACARS datalink management.

The DCMS uses these two AIMS functions:

- Data communication management function (DCMF)
- Flight deck communication function (FDCF).

The DCMS connects to many components of other systems to do its functions. These include:

- Flight deck printer
- Maintenance access terminal (MAT)
- Accept / reject / cancel buttons
- Control display units (CDUs)
- Cursor control devices (CCDs)
- Display units (DUs)
- Radio tuning panels (RTPs)
- VHF radios
- Satellite data unit (SDU).

PRINTER DRIVER

The print driver function controls all printing requests from the AIMS functions. It sends print jobs from AIMS functions to the flight deck printer and sends printer job status and errors back to the AIMS functions.

ETHERNET INTERFACE

The Ethernet interface supplies communications between the AIMS functions and these units:

- MAT
- Portable maintenance access terminals (PMATs).

ACARS DATALINK

The DCMS controls the aircraft communications addressing and reporting system (ACARS) datalink data.

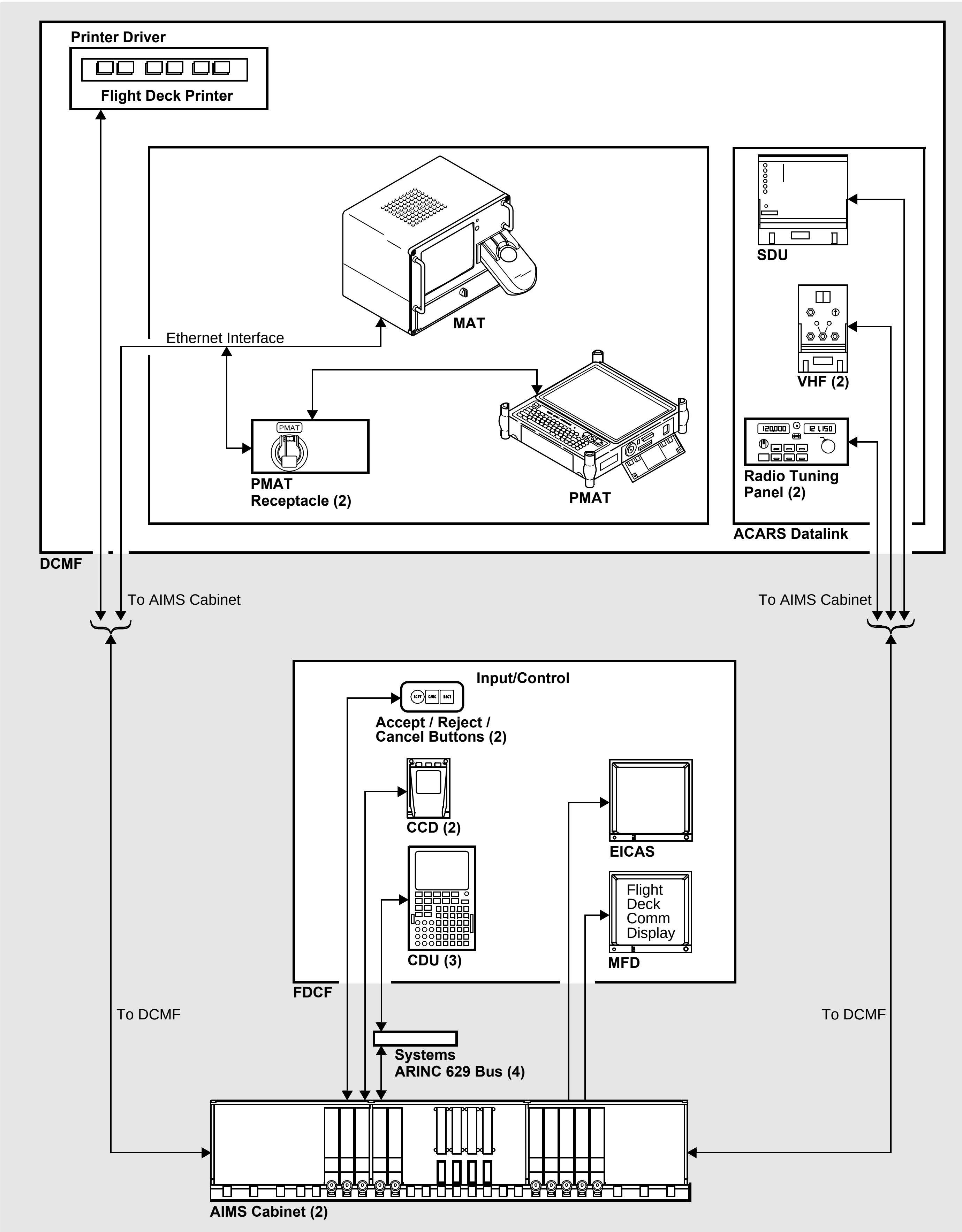
The FDCF supplies the flight crew interface for control of ACARS operations.

The DCMF finds if the VHF or the SDU is available for the ACARS. The DCMF transmits the digital data through the available system.

GROUND BASED SOFTWARE TOOL

The airlines can use the ground based software tool (GBST) to set these:

- Frequency selections
- Routes for data
- Message reject criteria.



Data Communication Management System

Features

ARINC 629

The 777 airplane uses ARINC 629 data buses. ARINC 629 data buses permit faster transfer of data between LRUs than ARINC 429 data buses. ARINC 629 data buses operate at a rate of 2 megabits per second. The buses are bi-directional and permit more than one transmitter on the same bus.

SATELLITE COMMUNICATION

The 777 has a satellite communication (SATCOM) system as standard equipment. SATCOM supplies reliable long range voice or data communication. The system can transmit and receive data that includes:

- Flight crew voice
- Passenger voice
- Data communication
- Telex
- Facsimile services.

CABIN SERVICES SYSTEM

A cabin services system (CSS) puts these functions together:

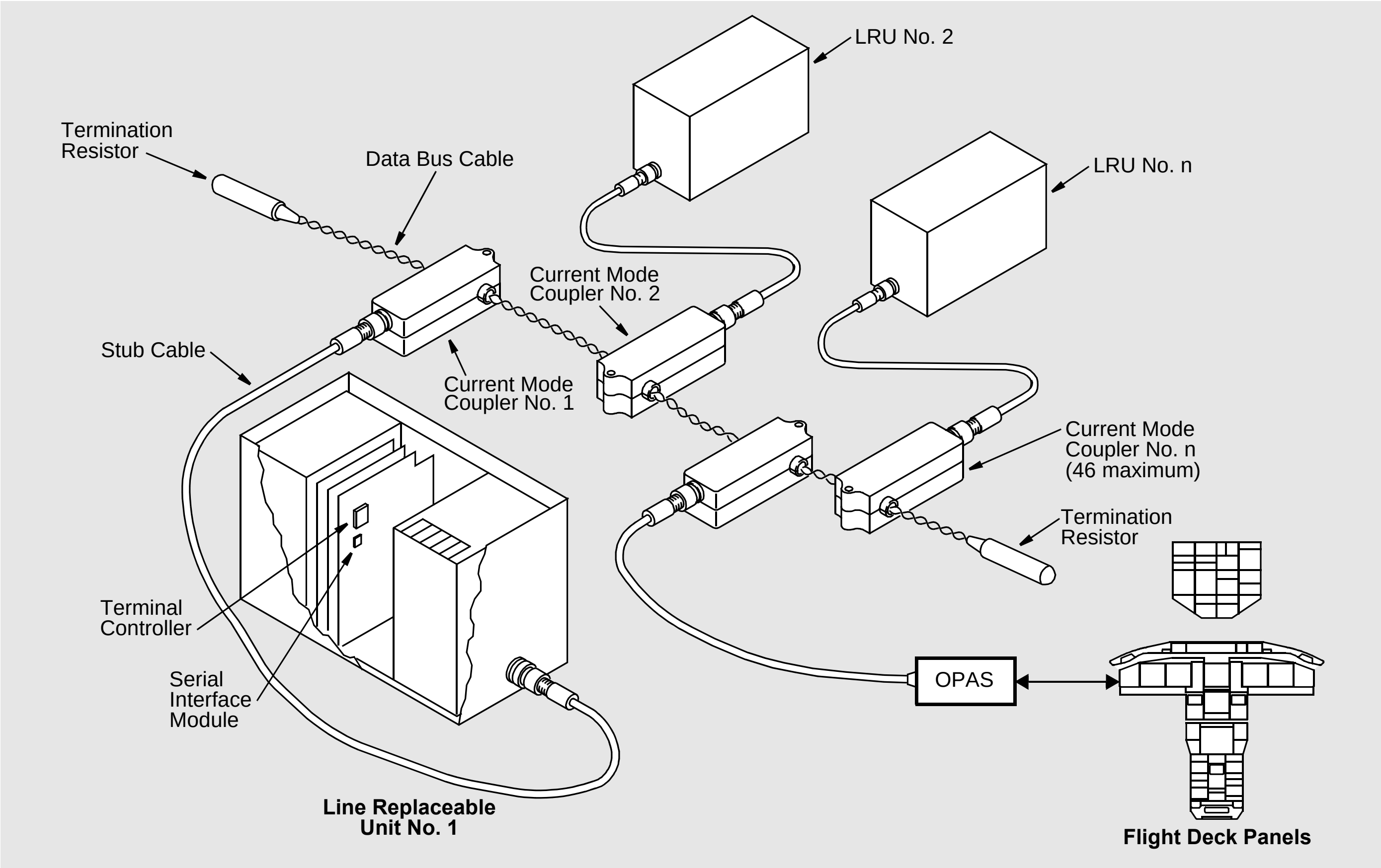
- Passenger address
- Cabin interphone
- Passenger service
- Cabin lighting.

The integration of these systems permits:

- The airline to set many passenger cabin configurations
- A central location for test and fault reports.

The CSS has a standard ARINC 628 interface that lets you add an in-flight entertainment (IFE) system.

- **ARINC 629 Communication System**
- **Flight/Service Interphone Systems**
- **Cabin Services System**
- **Ground Crew Call System**
- **Voice Recorder System**
- **VHF/HF Communication Systems**
- **SELCAL System**
- **SATCOM System**



ARINC 629 Communication System

ARINC 629 Communication System

The ARINC 629 communication system has these characteristics:

- Two way transmission
- Multiple transmitters
- Broadcast type
- Autonomous terminal access
- Time division multiplex.

It permits data communication between many terminals over the same bus. There are seven ARINC 629 buses on the 777.

The primary flight control system has three dedicated ARINC 629 flight control buses that connect with approximately 26 line replaceable units (LRU).

Four ARINC 629 system buses supply the main communication path between these systems:

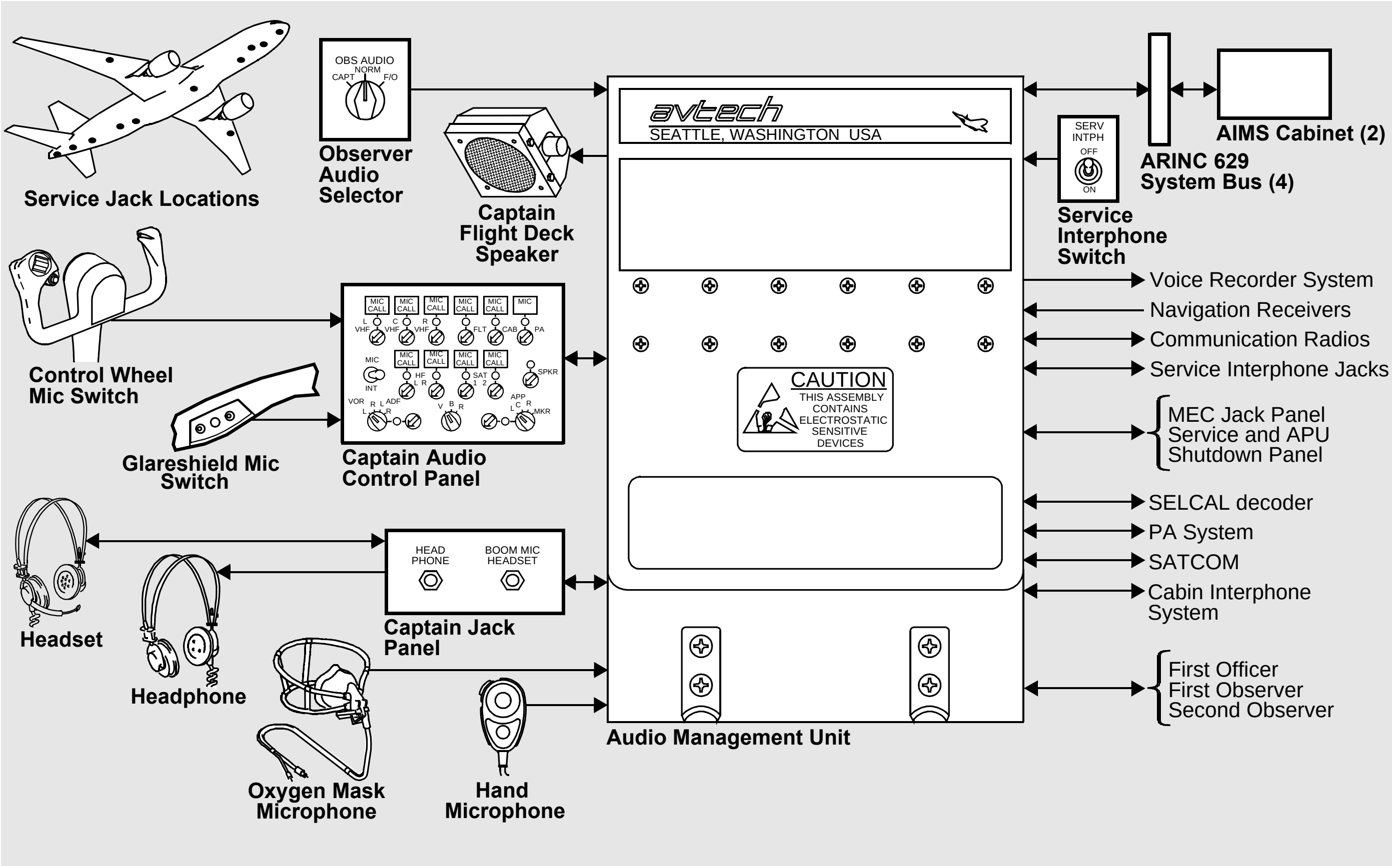
- Avionics
- Electrical
- Electro-mechanical
- Environmental control
- Propulsion.

The ARINC 629 system buses connect with approximately 53 LRUs. These buses operate independently from the flight control buses.

ARINC 629 components include terminal controllers and serial interface modules. These components are internal to the LRUs. As well as the LRU ARINC 629 components and the eleven ARINC 629 data bus cable assemblies, the ARINC 629 communication system includes stub cables and current mode couplers.

The LRUs use a coupler and terminal (terminal controller and serial interface module) to connect with the bus. Each terminal monitors the bus and does not transmit until there is a quiet period. Only one terminal on a bus transmits at a time. After a terminal transmits, three different timers make sure that it does not transmit again until all of the other terminals on the bus has an opportunity to transmit.

The overhead panel ARINC 629 system (OPAS) does a multiplex of the flight deck panel switch positions for transmission on the ARINC 629 system buses.



Flight/Service Interphone Systems

Flight Interphone System

The flight interphone system permits the flight crew members on the flight deck to communicate with each other and with:

- Audio communication systems
- Ground crew members.

There are four systems. The captain system is shown.

Switches on the audio control panels (ACPs) permit selection of the following types of audio:

- Communication transceiver audio
- Navigation receiver audio
- Cabin interphone audio
- Passenger address (PA) audio
- Flight interphone audio
- SATCOM audio.

Hand microphones, boom microphones, or oxygen mask microphones can be connected through the audio management unit (AMU) to the radio transceivers, cabin interphone system, or PA system. Functions selected on the ACP go digitally to the AMU.

The AMU uses new technology digital signal processing for clear sound quality. The AMU sends the selected audio to and from the flight deck.

Each flight crew member station has a jack outlet for a boom microphone/headset and headphones. There can be an optional fourth ACP for the second observer.

Mic switches are on each pilot glareshield and control wheel for the boom and oxygen mask microphones. Interphone switches are on the audio control panels.

Service Interphone System

The service interphone permits communication between the pilots, ground crew, and maintenance personnel.

Jacks for plug-in microphone and headsets are at various locations on the airplane. When the service interphone switch is ON, the service and flight interphone systems connect together.

Cabin Services System

The cabin services system (CSS) integrates many cabin and passenger systems. CSS controls these systems:

- Passenger address
- Cabin interphone
- Passenger service
- Cabin lighting.

The CSS also monitors and controls many cabin functions.

The integration of these systems permits control, monitor, and test of the system from a central location.

The CSS has a standard interface (ARINC 628) that allows the addition of an in-flight entertainment (IFE) system. The interface to the IFE is through a head-end interface and through a zone interface. The IFE controls functions of the passenger entertainment system and of airline applications.

Software controls the CSS. The CSS uses a configuration database to define the cabin interior configuration. Interior configuration changes are easy to do by changing the configuration database. The configuration database generator (CDG) is a menu-driven database editor that operates on a personal computer (PC). The CDG changes the database. After the change, the operator loads the database into the cabin services system through the cabin system control panel (CSCP). The CSCP stores many databases and operational software in memory.

Flight attendants use the CSCP for CSS functions and maintenance technicians use the CSCP for test and program functions.

The passenger address/cabin interphone (PA/CI) controller controls the passenger address (PA) and cabin interphone (CI) functions.

There is a zone management unit (ZMU) in each zone.

Each ZMU connects to the overhead electronics units (OEUs) and to the IFE through an ARINC 628 zone interface bus. Each ZMU also connects to one cabin area control panel (CACP) and up to five cabin attendant handsets (CAHs). These are the functions of the ZMU:

- Analog to digital and digital to analog audio conversion for the cabin interphone system
- Control the passenger service selections from the IFE and cabin light selections from the CACP.

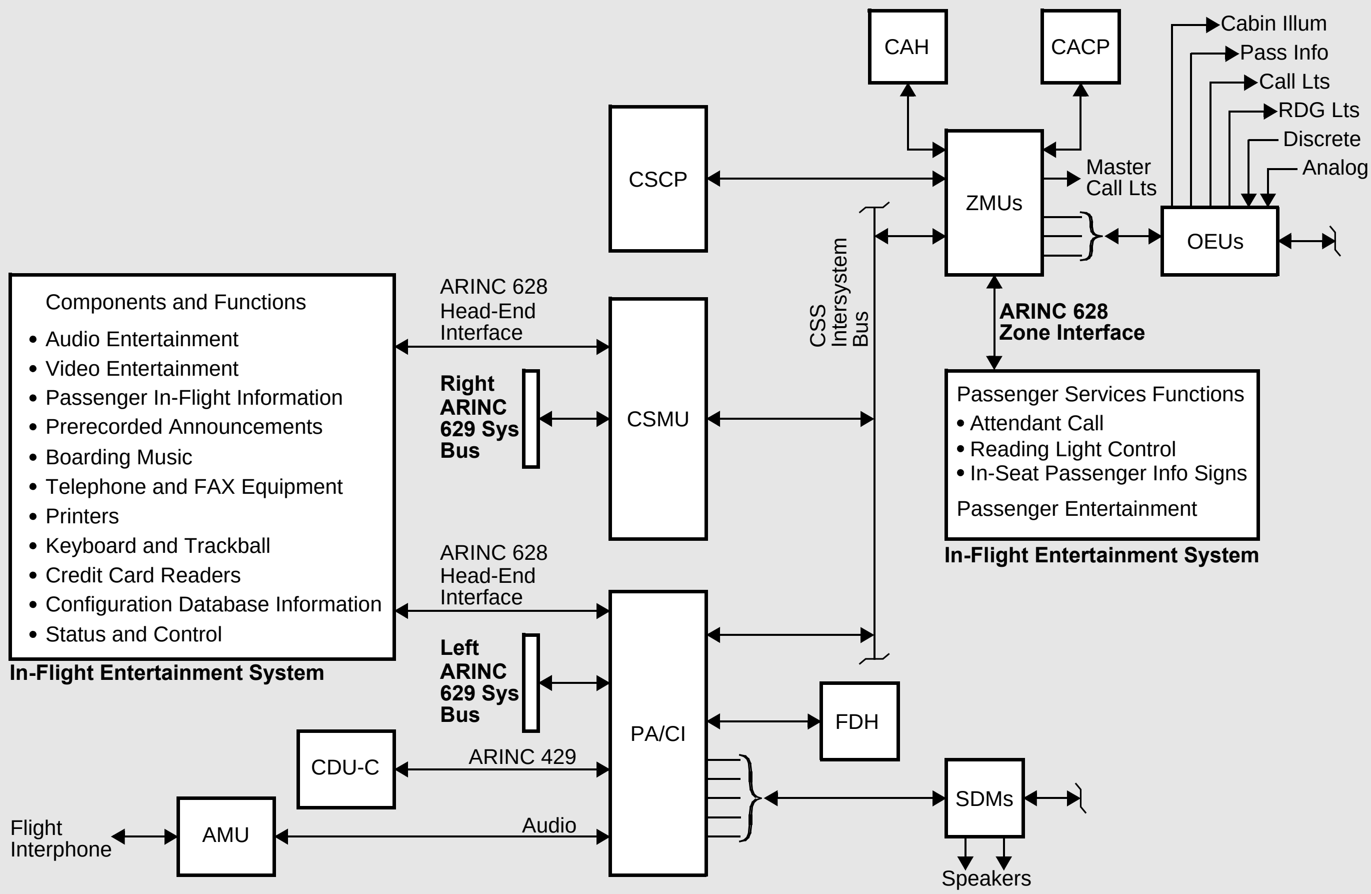
The ZMUs monitor the configuration database for the correct state of each light. They also have interfaces with the OEUs to control the lights.

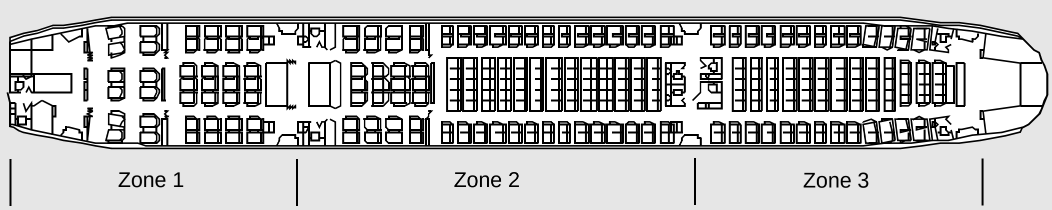
The airlines can add any of these IFE components and functions:

- Audio entertainment to the passengers
- Interactive video for passenger games and applications
- Video entertainment to the passengers
- Video on demand
- Passenger in-flight information computer (PIIC) to show navigation and flight data
- Prerecorded announcements and boarding music for the passenger address system
- Passenger telephone
- Facsimile equipment
- Cabin printer to supply paper copies of CSS data
- Keyboard/track ball/credit card reader for airline applications
- Airplane configuration information in the airplane configuration database
- Status and control.

Each passenger seat can have any of these IFE components:

- Seat video display
- Telephone handset
- Passenger controls
- Joystick
- Credit card reader.





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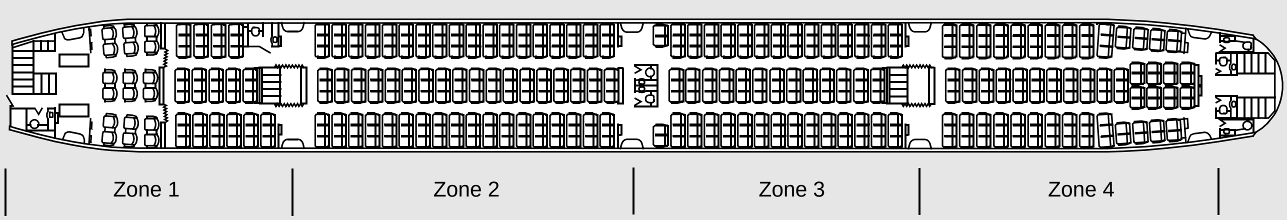


777-300

Cabin Services System

Cabin Interphone System

The cabin interphone (CI) function permits communication between cabin attendants and between cabin attendants and the flight crew.

The cabin interphone function uses these components:

- Passenger address/cabin interphone (PA/CI) controller
- Cabin attendant handsets (CAH)
- Zone management units (ZMU)
- Flight deck handset (FDH).

The cabin attendants use the CAH for communications on the cabin interphone.

Each CAH station has a two-number dial code. A station can make a call to other stations. A cabin station that receives a call gets a chime and a call light. The flight compartment gets a chime, a call light on each audio control panel (ACP), and a message on the center control display unit (CDU).

The ZMU is the interface between the CAH and the PA/CI controller.

The flight crew uses the flight interphone or the FDH as an interface with the CI. The audio management unit (AMU) uses the flight interphone audio and sends it to the PA/CI.

The PA/CI controller does these functions:

- Receives, sets priorities and sends out multiplexed audio and data to and from the ZMU
- Has an interface with the CDU to send messages and get dial data
- Sends and gets audio to and from the FDH and AMU
- Sends AIMS a signal to make a flight compartment chime and message.

The configuration database software controls the cabin interphone function.

Passenger Address System

The passenger address (PA) function sends announcements to the passenger cabin.

The passenger address function uses these components:

- Passenger address/cabin interphone (PA/CI) controller
- Ambient noise sensors (ANS)
- Speaker drive modules (SDM)
- Zone management units (ZMU)
- Cabin system control panel (CSCP)
- Cabin system management unit (CSMU).

Announcements come from the flight crew, the cabin attendants, or the IFE system. The IFE system sends.

- Prerecorded announcements
- Boarding music
- Video entertainment audio.

The airline can make the passenger cabin configuration in as many as six PA areas for announcements.

The PA/CI controller receives all audio inputs and selects the input with the highest priority. It makes the audio digital and sends it to the SDMs. The SDMs change the digital audio back to analog. Each SDM can operate one or two speakers.

Chimes are put together with the audio so passengers and crew hear them at the same time.

PA volume control is:

- From the configuration database
- Automatic
- Manual.

The configuration database sets the normal reference level for each speaker in flight.

Automatic control adjusts the normal reference level because of flight conditions.

The attendants can also make manual adjustments from the CSCP or a CACP.

The PA/CI controller has two circuits for the PA function that are the same and two circuits for the CI function that are the same. Each has a primary and alternate circuit. The attendant selects an alternate circuit from the attendant switch panel if a primary circuit has a failure.

Passenger Service System

The passenger service system (PSS) controls reading lights, call lights, and passenger information signs.

The PSS uses these components:

- Zone management unit (ZMU)
- Cabin area control panel (CACP)
- Cabin system control panel (CSCP)
- Cabin system management unit (CSMU)
- Overhead electronics unit (OEU).

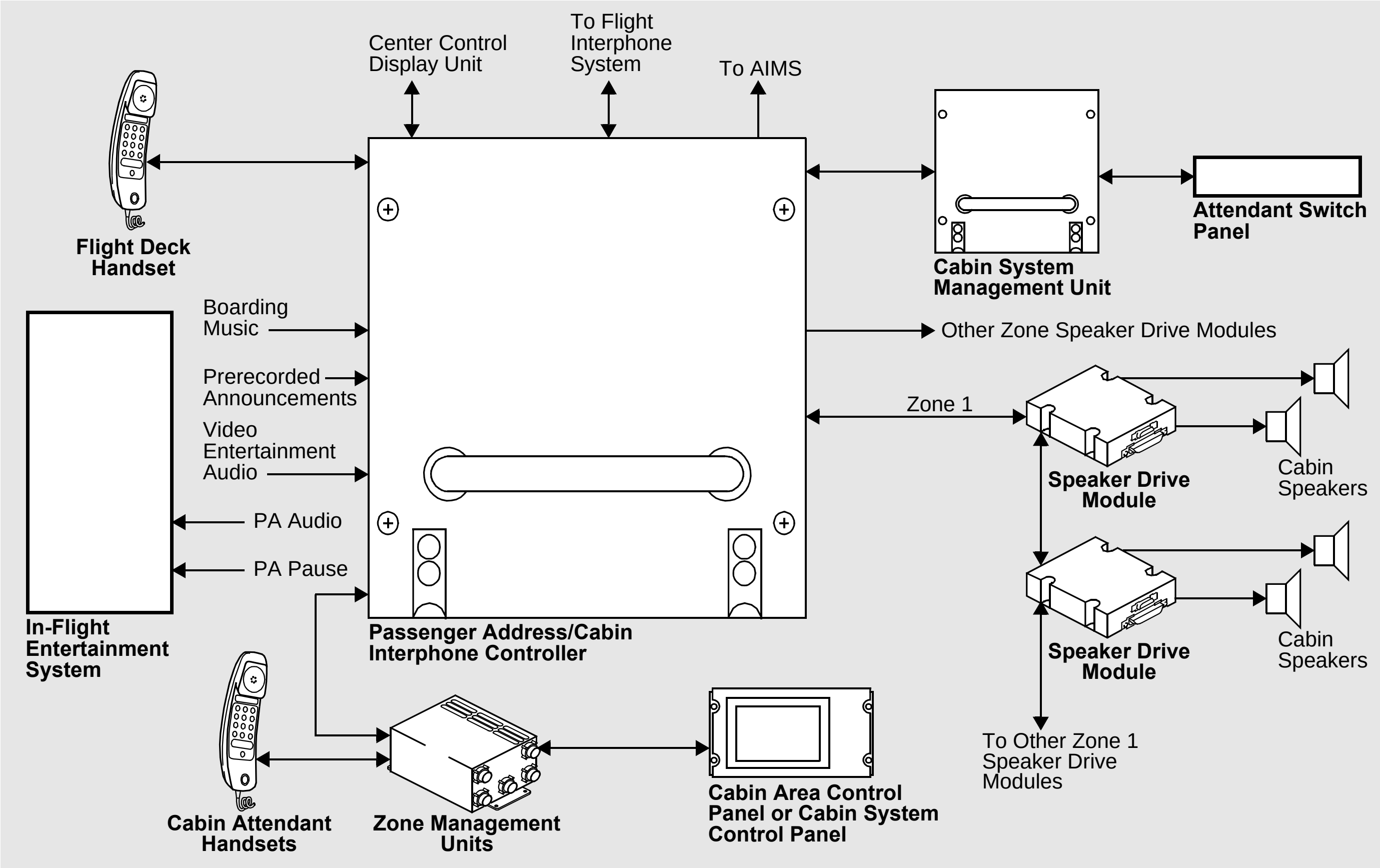
The in-flight entertainment (IFE) system lets passengers control their reading lights and passenger-to-attendant call functions. The IFE system sends status and configuration database data to the PSS.

The ZMU supplies an interface from the IFE system to the OEU. The OEU controls the light and the attendant call function.

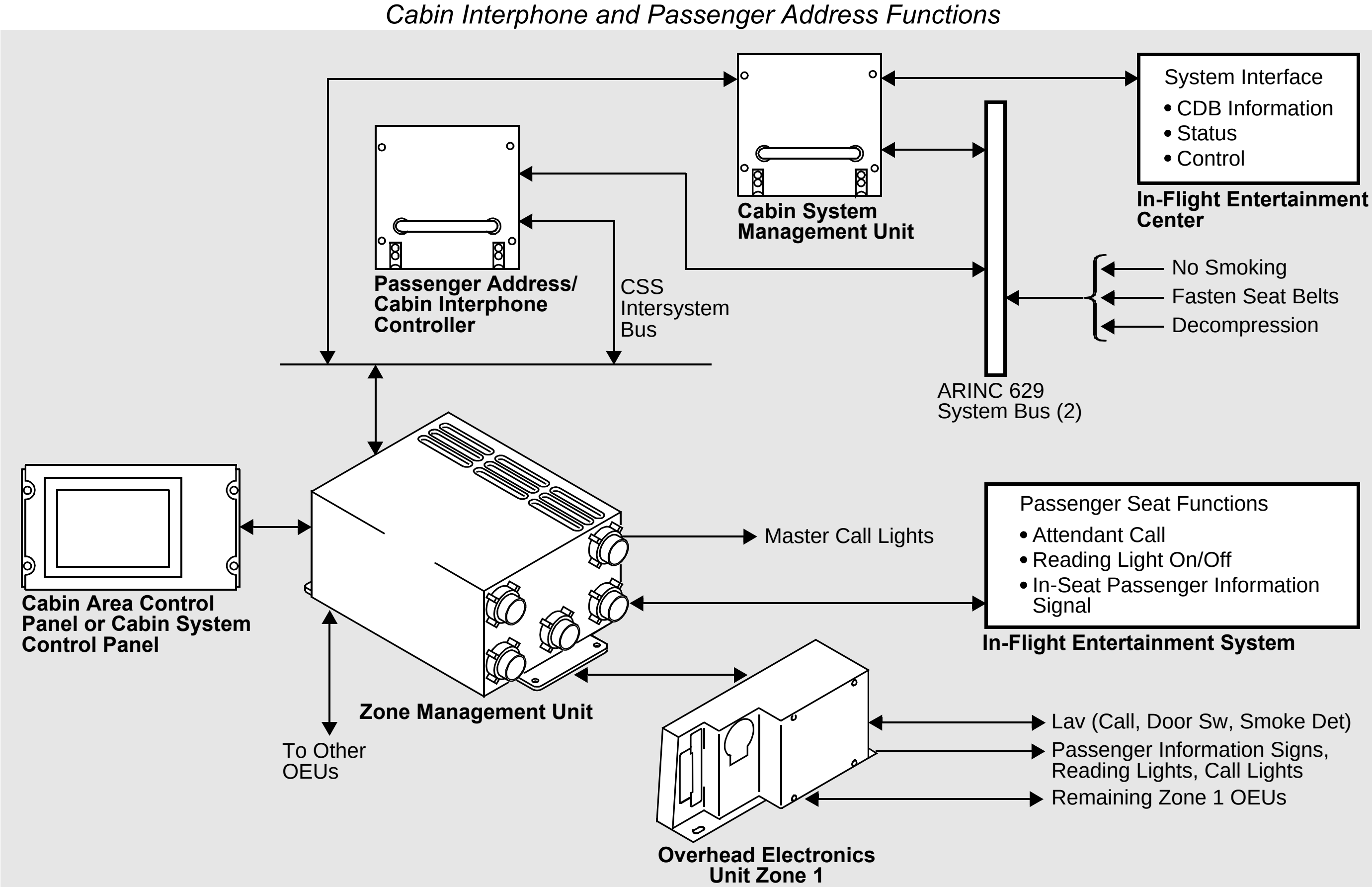
The lavatories have an interface with the OEU for these functions:

- Lavatory call
- Lavatory occupied
- Smoke detection
- Return to seat.

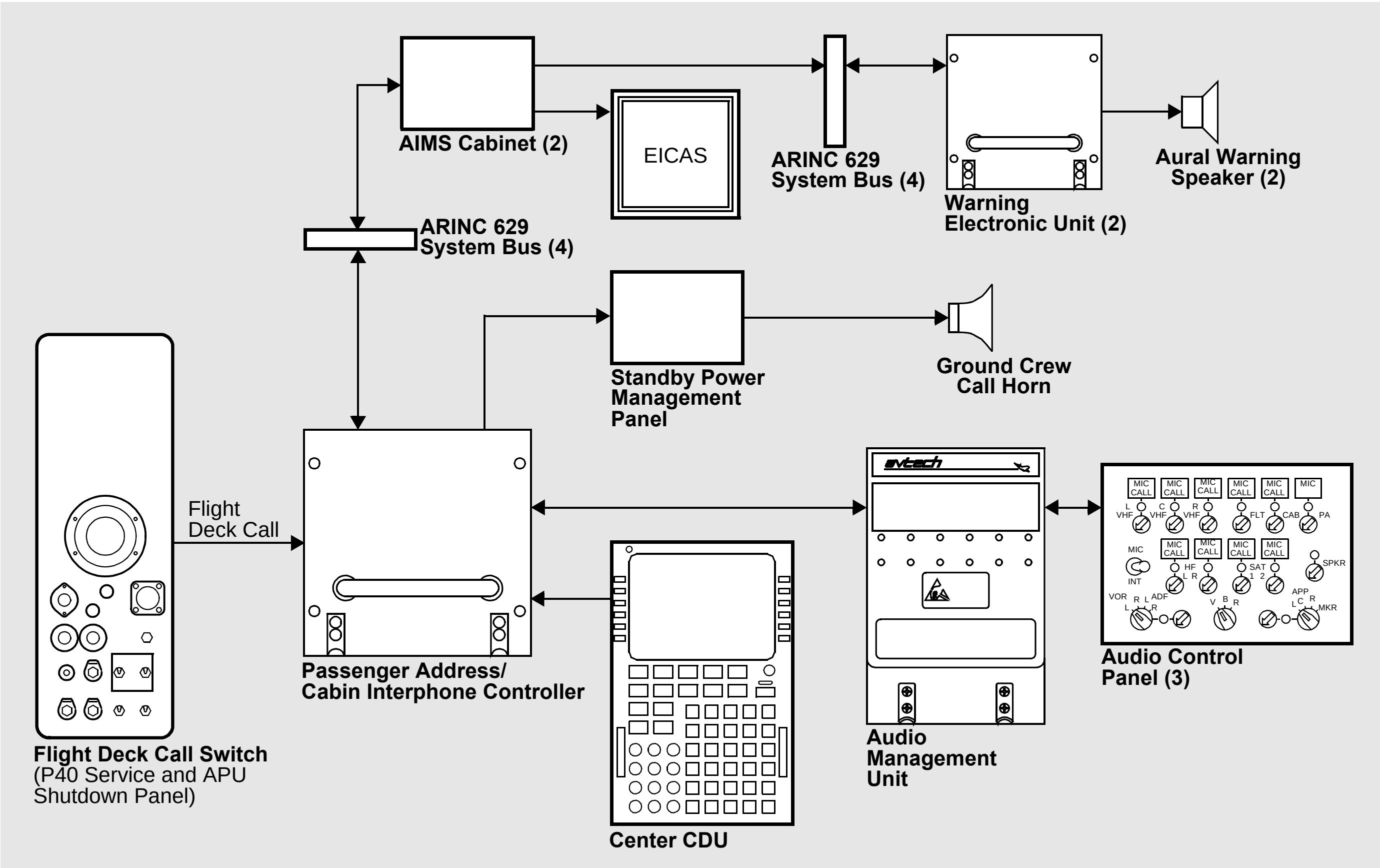
The cabin attendants control passenger reading and cabin lights and do resets of attendant calls from the CACP or the CSCP.



Cabin Interphone and Passenger Address Functions



Passenger Service Functions



Ground Crew Call System

Ground Crew Call System

The flight crew and the ground crew use the ground crew call system to alert each other. The system supplies aural and visual signals in the flight deck and in the nose wheel well area.

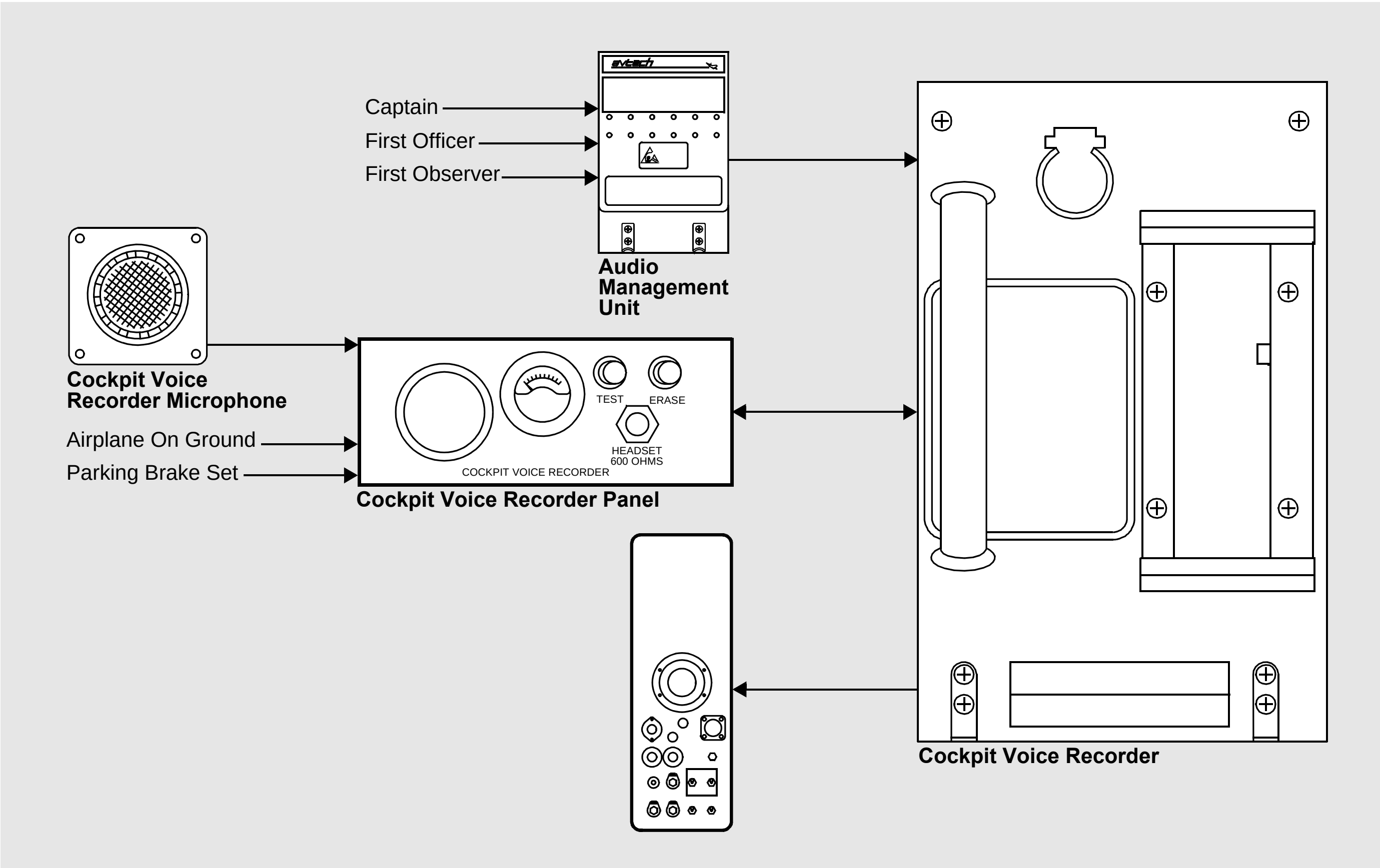
When the flight crew selects the ground crew call code on the cabin interphone menu of the center control display unit (CDU), the ground crew call horn sounds in the nose wheel well.

There is a flight deck call switch on the P40 Service and APU shutdown panel. When the ground crew operates this switch:

- The audio control panels FLT call lights come on
- A message is shown on EICAS
- A chime sounds through the aural warning speakers.

The ground crew call horn also comes on when the airplane is on the ground and one of these occurs:

- There is an equipment cooling failure
- The air data inertial reference unit (ADIRU) is on and there is no ac power on the airplane.



Voice Recorder System

Voice Recorder System

The four-channel, solid-state cockpit voice recorder with flight deck area microphone records the most recent 30 minutes of flight crew communications. A cockpit voice recorder that records for 120 minutes is also available.

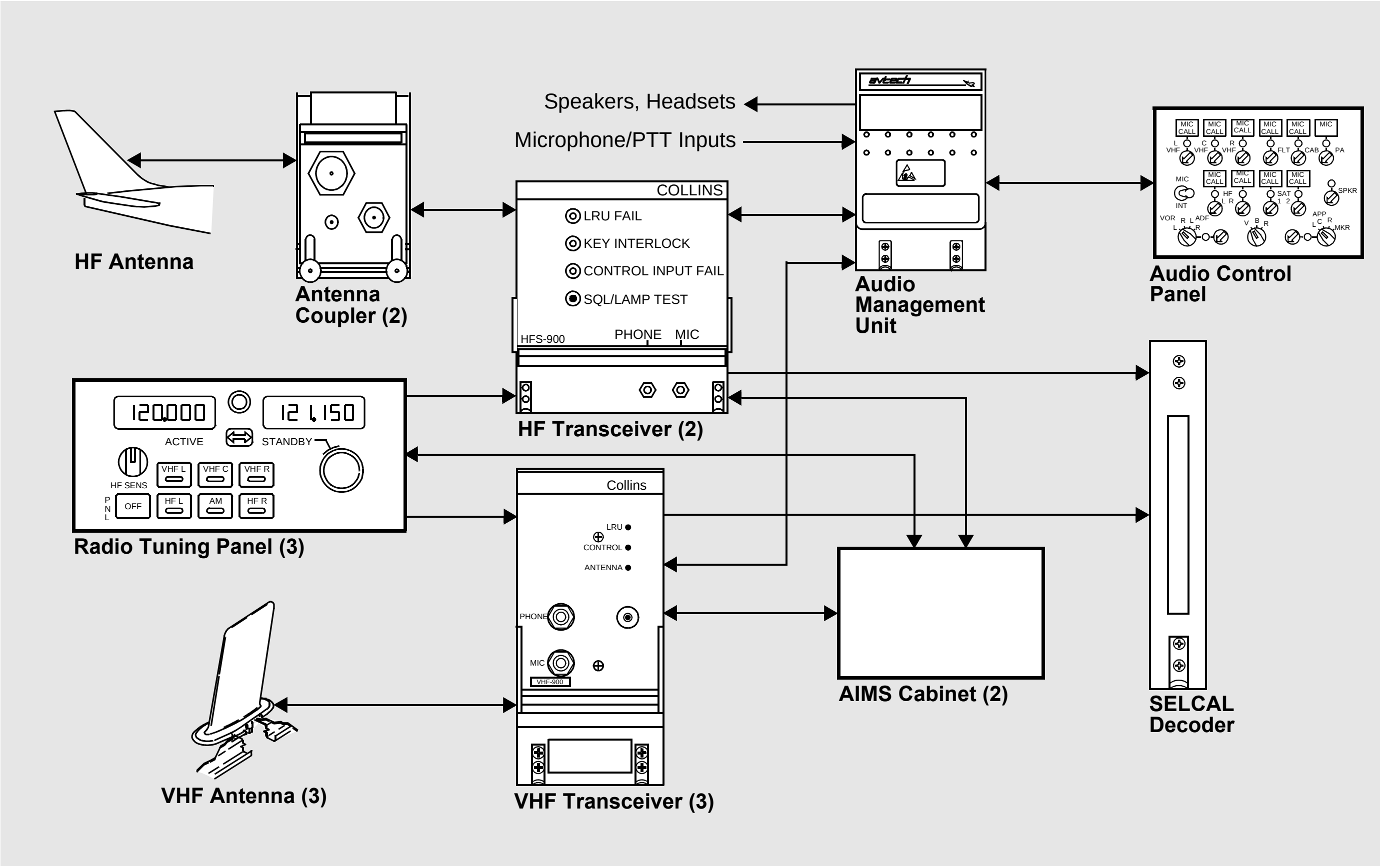
Input to the voice recorder is from the cockpit voice recorder microphone and from the captain, first officer, and first observer audio hot microphone inputs to the AMU.

The cockpit voice recorder panel has test and erase buttons and is on the maintenance panel in the flight deck. The cockpit voice recorder microphone is on the overhead panel in the flight deck.

There is a voice recorder jack on the service and APU shutdown panel that permits the ground crew to monitor flight deck conversation.

The recorder unit is in the E7 equipment rack. It includes an underwater locator beacon (ULB).

To do a bulk erase of the cockpit voice recorder, the airplane must be on the ground, and the parking brake set.



VHF/HF Communication Systems

VHF/HF Communication Systems

The very high frequency (VHF) communication system supplies line-of-sight voice and data communication from air to ground or air to air. The short to medium range of VHF keeps interference with distant stations at the same frequency to a minimum.

Each VHF communication system includes a transceiver and a dedicated antenna.

The high frequency (HF) communication system permits voice communication over distances much farther than line-of-sight radio systems. Communication from aircraft to ground stations or other aircraft is provided during long over water flights.

Each HF communication system includes a transceiver, an antenna coupler, and a common antenna. The antenna is on the leading edge of the vertical stabilizer. The antenna couplers are in the vertical stabilizer behind the antenna. The antenna coupler matches the impedance of the transmission line to that of the transceiver.

Frequency selection for each transceiver is from any of the three radio tuning panels (RTPs). Any RTP can provide tuning data to any of the VHF or HF transceivers.

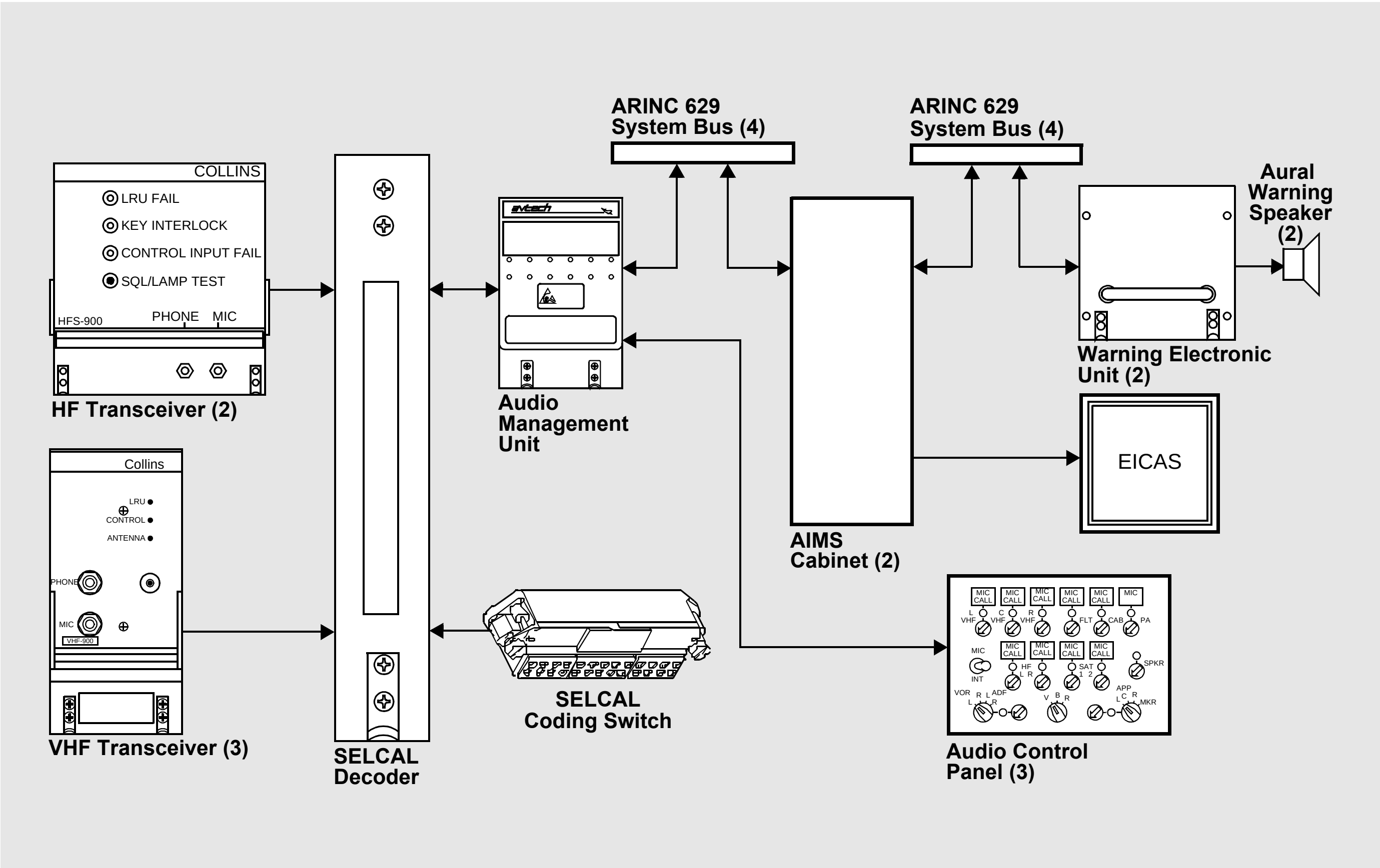
A radio tuning switch selects one of the five transceivers. The frequency selectors select the desired frequency. This shows on the liquid crystal display standby frequency window. The frequency transfer switch toggles between active and standby frequencies.

The VHF radios interface with the AIMS data communication management function (DCMF). The DCMF supplies tuning data to the RTPs. This frequency shows on the RTPs standby frequency window. The flight crew selects that frequency to tune the VHF radios.

The audio control panels supply microphone selection, headphone monitoring, and PTT functions.

The central maintenance computing function (CMCF) of the AIMS tests and monitors the VHF and HF communication systems.

The digital flight data acquisition function (DFDAF) of the AIMS receives microphone keying information. The flight data recorder records the microphone keying information.



SELCAL System

SELCAL System

The selective calling (SELCAL) system monitors all communication radios in the airplane. The system alerts the flight crew when it receives a ground call with the correct airplane code. This removes the need for continuous monitoring of the communication radios by the flight crew.

The SELCAL decoder receives audio signals from the VHF and HF communication systems.

The SELCAL decoder processes the SELCAL messages and sends them to the audio management unit. The audio management unit sends a signal to the ACP and to AIMS.

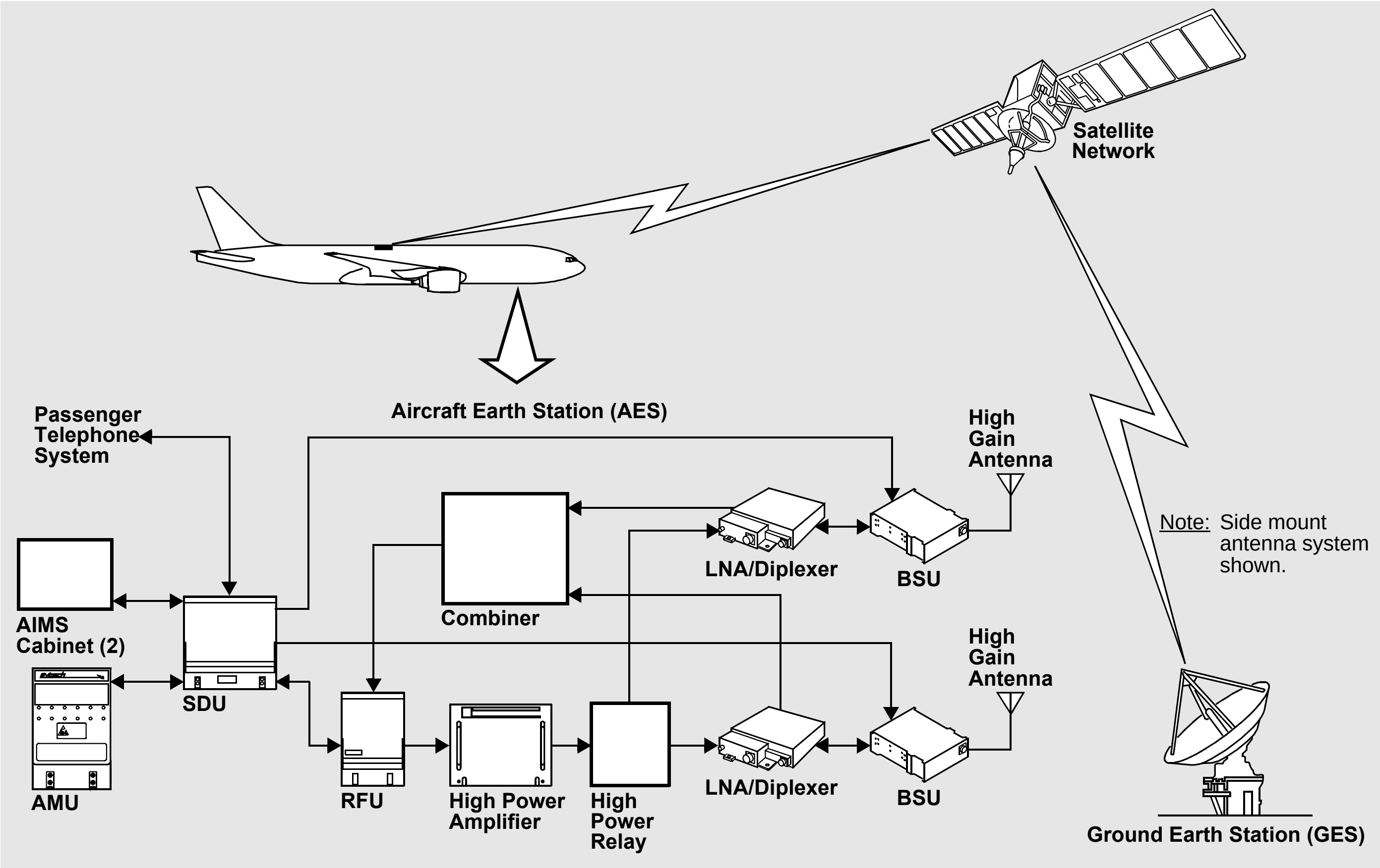
The ACP turns the call light on. AIMS makes a COMM medium message, SELCAL, which shows on the EICAS display. AIMS sends a signal to the warning electronic unit (WEU) which causes the hi/lo chime to sound.

These are the SELCAL indications:

- A call light on the ACP
- An EICAS message
- A hi/lo chime.

The SELCAL supplies indications only if the signal received has the airplane unique SELCAL code.

The flight crew pushes the appropriate transmit switch on the ACP or the appropriate PTT to stop the indications.



SATCOM System

Satellite Communication (SATCOM) System

The SATCOM system transmits and receives data and voice messages. The system uses satellites as relay stations for long distances. SATCOM is more reliable than the HF communication system because atmospheric interference does not have an effect on it.

The system has the satellite network, the ground earth stations (GES), and the aircraft earth stations (AES).

The satellite network does a relay of radio signals between the AES and the GES. Each GES is a fixed radio station that has interfaces with communication networks through ground links and the aircraft earth stations through the satellite. The AES is the SATCOM system on the airplane that has interfaces with different airplane communication systems and the ground earth stations.

AIRCRAFT EARTH STATION DESCRIPTION

The basic SATCOM configuration has a high-gain system that uses side-mounted antennas.

The satellite data unit (SDU) is the interface between all other related airplane systems and the SATCOM system. The radio frequency unit (RFU) changes the signal from the SDU to an L-band signal for the high power amplifier (HPA). The HPA supplies sufficient radio frequency power to the antenna. The low noise amplifier (LNA) and diplexer are one unit. The diplexer connects transmit signals from the HPA to the antenna. It also connects receive signals from the antenna to the LNA. The LNA does an amplification of the low level L-band signal from the antenna. The SDU sends directional control signals to the beam steering unit (BSU). The BSU electronically controls the antennas to point the beam at the necessary satellite.

The AES has interfaces with the data communication management system (DCMS) for transmission and reception of data messages. The AES also has interfaces with the passenger telephone system and the audio management unit (AMU) for voice call audio and control signals.

Features

NEW AVIONICS

The 777 uses some new avionics systems such as the highly fault tolerant, air data inertial reference system (ADIRS). The ADIRS combines the air data system and the inertial reference system into two line replaceable units (LRUs), the air data inertial reference unit (ADIRU) and the secondary attitude air data reference unit (SAARU).

HIGH RELIABILITY

Because there are only two main LRUs in this system instead of three ADCs and three IRUs, there is less weight. Also, the high reliability of the air data inertial reference system decreases the need for maintenance and spares.

SATELLITE NAVIGATION

The 777 uses the newest in satellite navigational systems, the global positioning system (GPS). GPS gives improved navigation accuracy. This saves fuel and improves the airline on-time performance.

COMMON COMPONENTS

The 777 uses many common avionics LRUs that the 747-400, 767, and 757 use. The use of common avionics equipment decreases the cost of maintenance and spares.

- **Air Data Inertial Reference System (ADIRU, SAARU, ADM/ Pitot-Static)**
- **Navigation Radios (VOR, Marker Beacon, ILS, ADF, DME)**
- **Global Positioning System**
- **Radio Altimeter System**
- **Air Traffic Control/Mode S System**
- **Traffic Alert and Collision Avoidance System**
- **Ground Proximity Warning System**
- **Weather Radar System**
- **Warning Electronic System**
- **Clock System**

Air Data Inertial Reference System

The ADIRS consists of:

- One ADIRU
- One SAARU
- Six air data modules (ADMs)
- Two standby air data modules (SADMs)
- A standby attitude indicator
- The air data sensors.

The ADIRS operates the same as a system of three IRUs, two ADCs and pressure, temperature, and angle of attack sensors. The ADIRS sends primary, secondary, and standby air data and inertial reference information to the flight deck displays, flight controls, autopilot system, and other airplane systems.

ADIRU

The ADIRU has these components:

- Six ring laser gyro sensors
- Six linear accelerometer sensors
- Four processors
- Three power supplies
- Three dual-channel ARINC 629 interfaces.

The ring laser gyros and linear accelerometers are along six non-parallel, symmetrically skewed axes. This orientation gives a fault-tolerant system.

IRU Function

The ADIRU uses ring laser gyros and accelerometers to sense angular rates and linear accelerations. The ADIRU calculates this data:

- Attitude (pitch, roll, and yaw)
- Position (latitude and longitude)
- True heading
- Magnetic heading
- Inertial velocity vectors
- Linear accelerations
- Angular rates
- Track angle
- Wind speed and direction
- Inertial altitude
- Vertical speed.

If failures occur, all IRU functions are available with:

- Four gyros
- Four accelerometers
- Two power supplies
- One processor
- A single ARINC 629 interface.

The ADIRU has one ON/OFF switch on the overhead panel. When the switch is ON, the ADIRU gets power.

When the On/Off switch is OFF, the ADIRU goes off when the airplane is on the ground and less than a certain ground speed.

ADC Function

The four processors get air data from the air data modules. The ADIRU gives these air data outputs:

- Altitude rate
- Pressure altitude
- Computed airspeed
- Mach number
- True airspeed
- Static air temperature
- Total air temperature
- Impact pressure
- Total pressure
- Static pressure
- Angle-of-attack.

Secondary Attitude Air Data Reference Unit (SAARU)

The SAARU supplies pitch and roll attitude to the standby attitude indicators. It is also the secondary source of inertial navigation and air data for the PFDs, primary flight controls system (PFCS), autopilot flight director system (AFDS) and other airplane systems.

During a catastrophic failure of the ADIRU, the SAARU gives the AFDS reduced navigation data.

IRU and Air Data Functions

The SAARU uses:

- Four fiber optic rate gyros
- Four analog linear accelerometers
- Two processors
- Three ARINC 629 interfaces.

Three of the gyro and accelerometers sensors are on the pitch, roll, and yaw axes and the fourth sensor pair is on a skewed axis.

The SAARU calculates these parameters:

- Pitch and roll attitude and heading
- Angular rates about the airplane pitch, roll, and yaw axes
- Linear accelerations along the pitch, roll, and yaw axes
- Barometric inertial altitude
- Vertical speed
- Computed airspeed
- True airspeed
- Altitude
- Altitude rate
- Static air temperature
- Total air temperature
- Mach number
- Angle of attack.

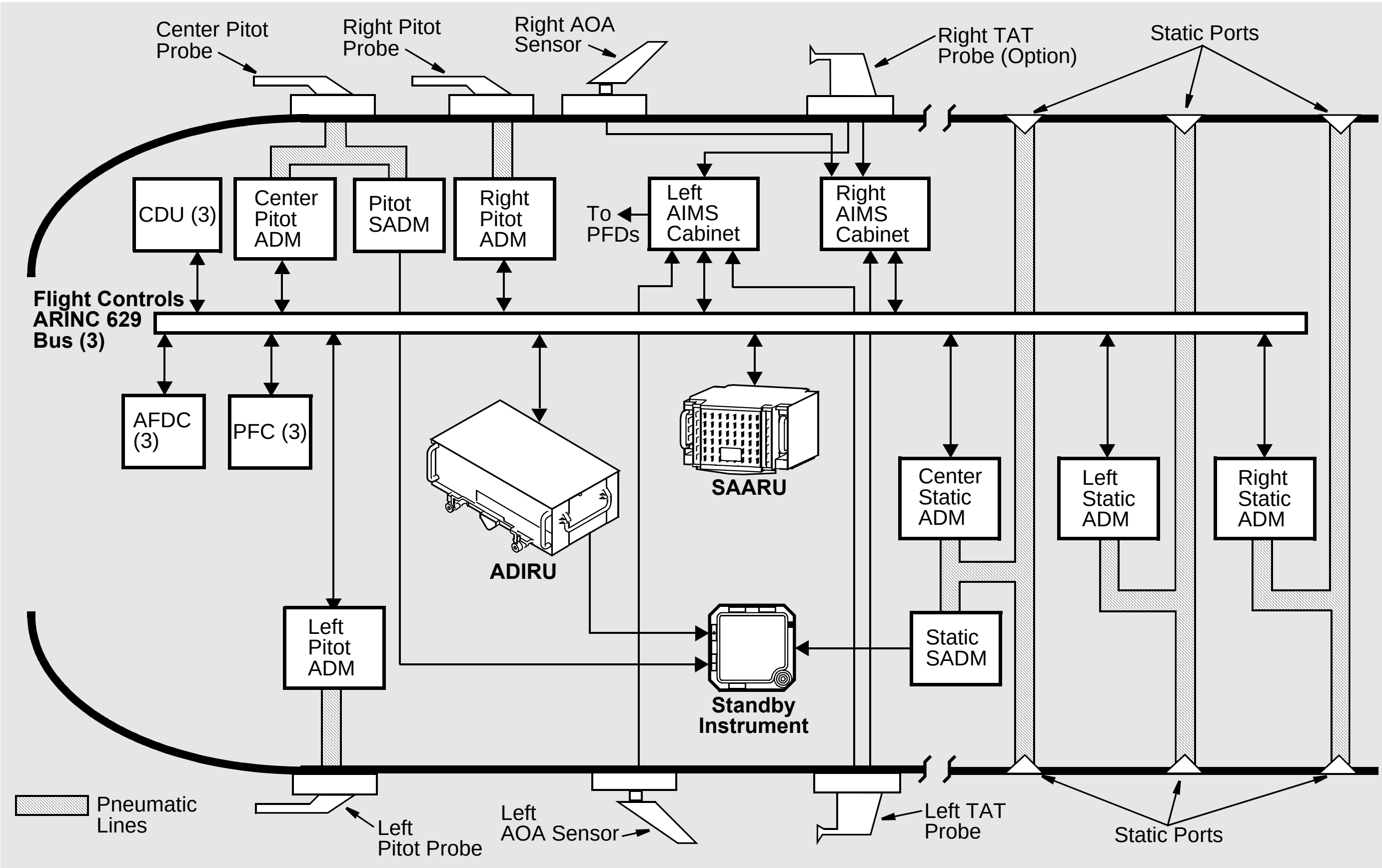
The SAARU sends pitch and roll attitude information on an ARINC 429 data bus to the standby attitude indicator.

The SAARU has no manual mode control for operation. It begins operation when power is applied to the airplane.

ADIRS Interface

You enter barometric correction on the onside EFIS control panel. If one of the EFIS control panels fail, barometric corrections can come from the onside CDU.

There are two AIR DATA/ATT source select switches on the flight deck.



Air Data Inertial Reference System

ADIRS Interface (Continued)

The switches control the source of display data for the on-side PFD. The primary source of display data is the ADIRU, and the secondary source of display data is the SAARU.

The ADIRU sends data on the left and right ARINC 629 flight control buses and gets data from all three ARINC 629 flight controls buses.

The SAARU sends data on the center flight controls bus and gets data from the left, center, and right flight controls buses.

The ADIRU and the SAARU send inertial reference data and air data to these units:

- AIMS
- AFDS
- PFCS
- CDUs.

AIMS sends the inertial reference data and air data to many other airplane systems and systems components. These include:

- GPS
- WES
- TCAS
- EEC
- APU.

The ADIRU and SAARU store fault data in their nonvolatile memory. You use the maintenance access terminal (MAT) to get the fault data.

Air Data Modules

Each pitot probe and static port connects to an air data module (ADM). The ADMs change the air pressure into ARINC 629 digital data. The ADIRU and SAARU get the 629 air data from the ADMs.

The center pitot probe and the center static ports also have a standby air data module (SADM). The standby altimeter and airspeed indicator get the 429 air data from the SADMs.

Three flat panel LCD standby instruments show this data:

- Attitude from the SAARU
- Indicated airspeed
- Altitude.

Air Data Sensors

The AOA sensors send analog signals to the on-side AIMS cabinet.

The TAT probe is a dual element probe with two analog outputs. One output goes to the right AIMS cabinet, and the other goes to the left AIMS cabinet.

Navigation Radios

The navigation radios supply reference data for instrument navigation. The flight management computing function (FMCF) of AIMS supplies most of the control for the navigation radios.

VHF Omnidirectional Ranging System

The VHF omnidirectional ranging (VOR) system supplies bearing and deviation signals relative to ground stations to the FMCF and the NDs.

The FMCF uses VOR data to calculate airplane position.

A dual element VOR antenna is on the top of the vertical stabilizer.

Marker Beacon System

The marker beacon system gives displays and aural tones in the flight deck when the airplane passes over a particular geographical location. The marker beacon receiver is a module in each VOR receiver. The marker beacon function operates in the left system only.

Distance Measuring Equipment System

The distance measuring equipment (DME) system supplies slant range distance between the airplane and a ground station to the FMCF and the NDs. The distance shows on the NDs. The FMCF uses DME distance to calculate airplane position.

The DME system supplies suppression pulses to the ATC transponders and TCAS. This is because DME frequencies are in the ATC and TCAS frequency range.

Automatic Direction Finder System

The automatic direction finder (ADF) receives radio signals from a ground station. It supplies bearing information to the NDs and audio to the flight deck. Some ADF stations in major terminal areas provide weather information.

Each ADF system has an integral sense and loop antenna and a receiver. The ADF data shows on the NDs.

Instrument Landing System

The instrument landing system (ILS) supplies precision approach guidance during instrument approaches to the NDs, PFDs, and AFDCs. The FMCF uses ILS data to calculate airplane position.

The PFDs show localizer and glideslope deviation. When the EFIS control panels are in the APP mode, the NDs show:

- ILS course pointer
- ILS source annunciator
- DME distance
- Localizer and glideslope deviation
- Selected ILS course
- ILS frequency/identifier.

When the airplane is on approach, the AFDCs send a discrete to each multi-mode receiver (MMR). This discrete prevents ILS test and tuning. The AFDCs also control the position of the localizer and glideslope antenna switches.

The ILS system uses the localizer radome antennas during approach. The system uses the VOR antenna to help the pilot maintain a straight track during takeoff.

The system uses the glideslope track antennas on the leading edge of the nose landing gear doors when the landing gear is down and locked.

Navigation Radio Tuning

The flight management computing function (FMCF) of AIMS tunes the VOR, ILS, DME, and ADF systems.

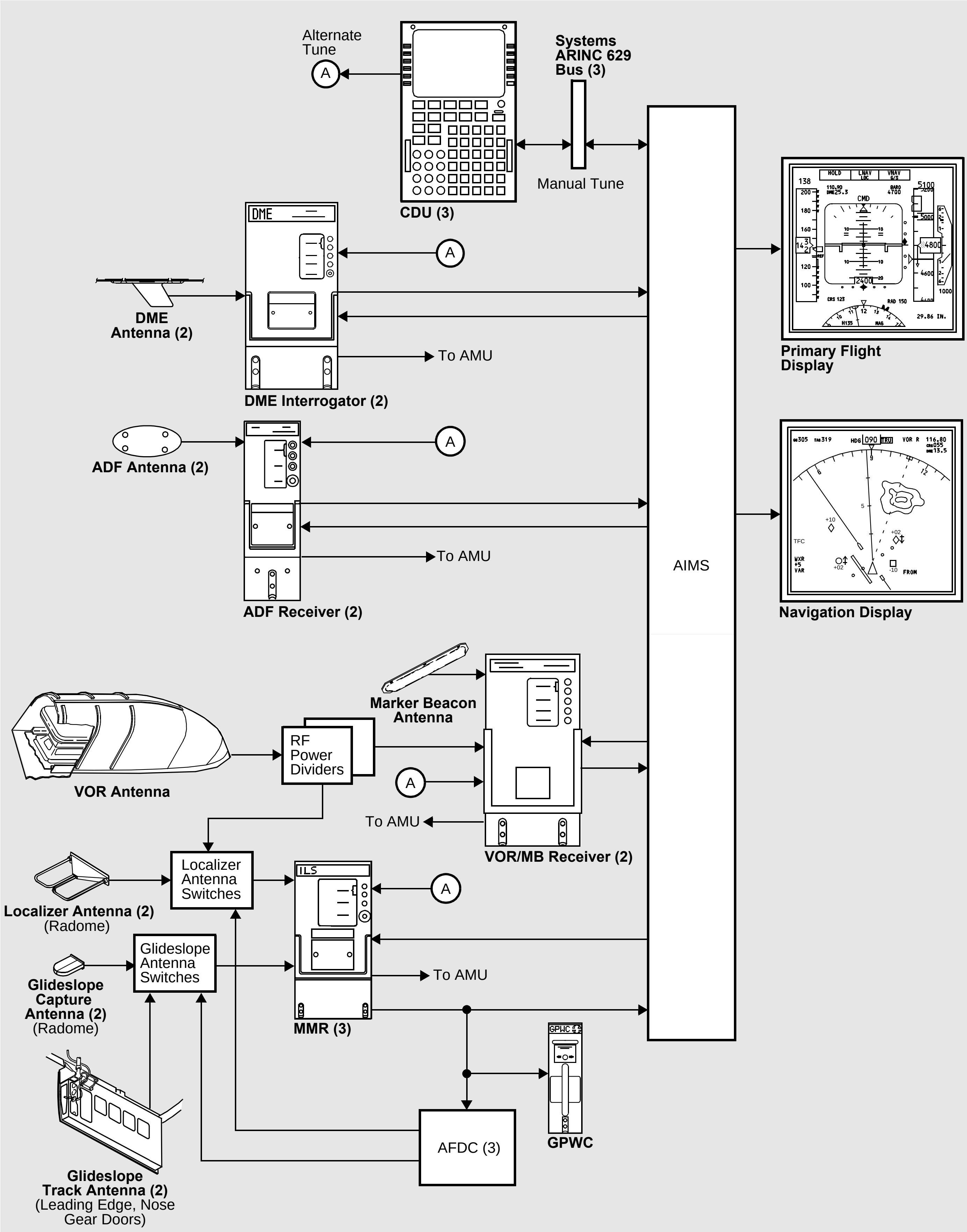
The onside control display units (CDUs) supply manual tuning if AIMS fails.

Audio Interface

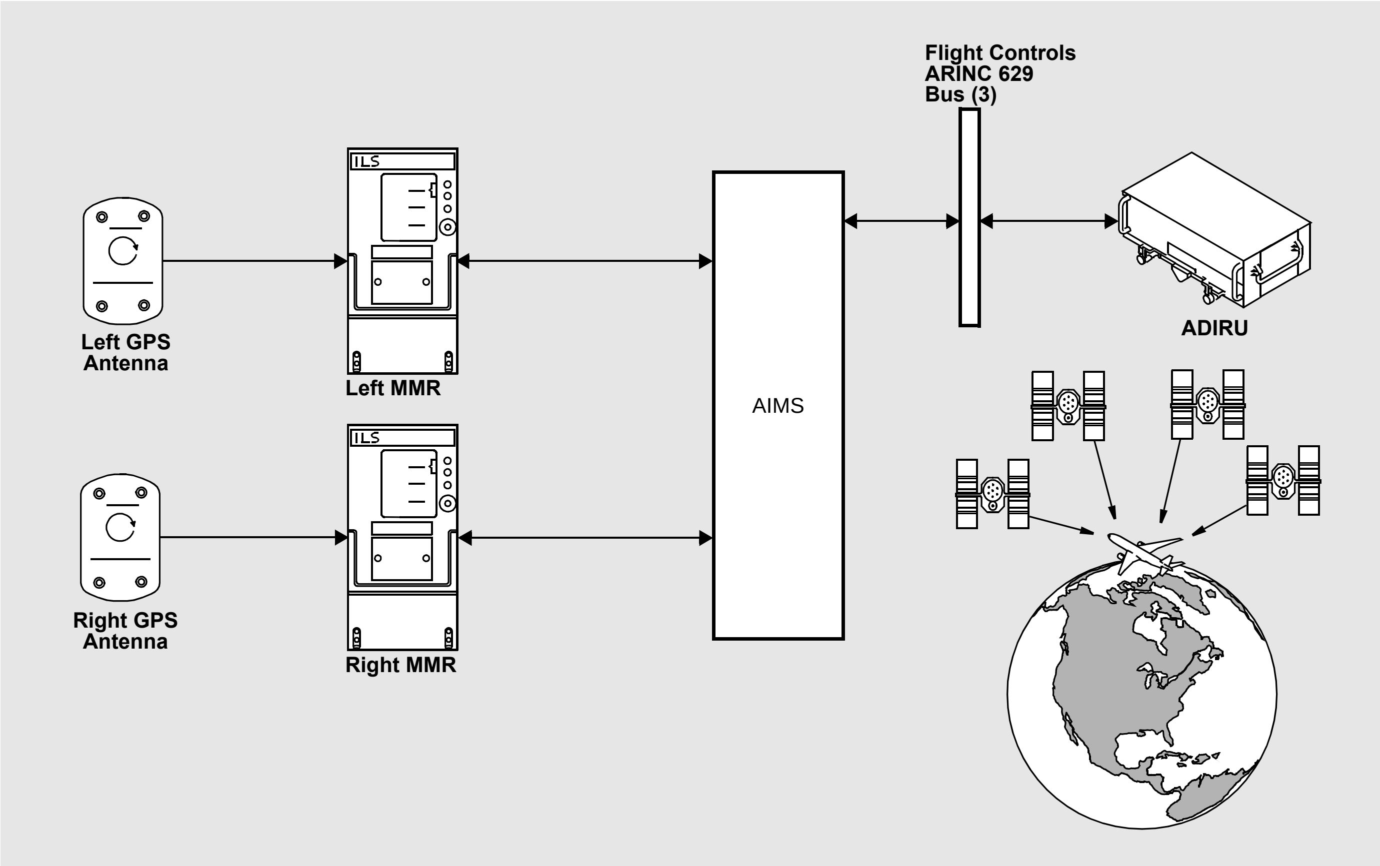
Audio from the VOR, ILS, DME, ADF, and marker beacon systems goes to headsets and speakers in the flight deck through the audio management unit.

Fault Reporting And Testing

The central maintenance computing function (CMCF) of AIMS supplies test and fault reporting functions for the navigation radio systems.



Navigation Radios



Global Positioning System

Global Positioning System

The global positioning system (GPS) uses navigation satellites to supply accurate airplane position to the FMCF, ADIRU, and the flight crew.

The GPS calculates this data:

- Airplane latitude
- Airplane longitude
- Airplane altitude
- Time.

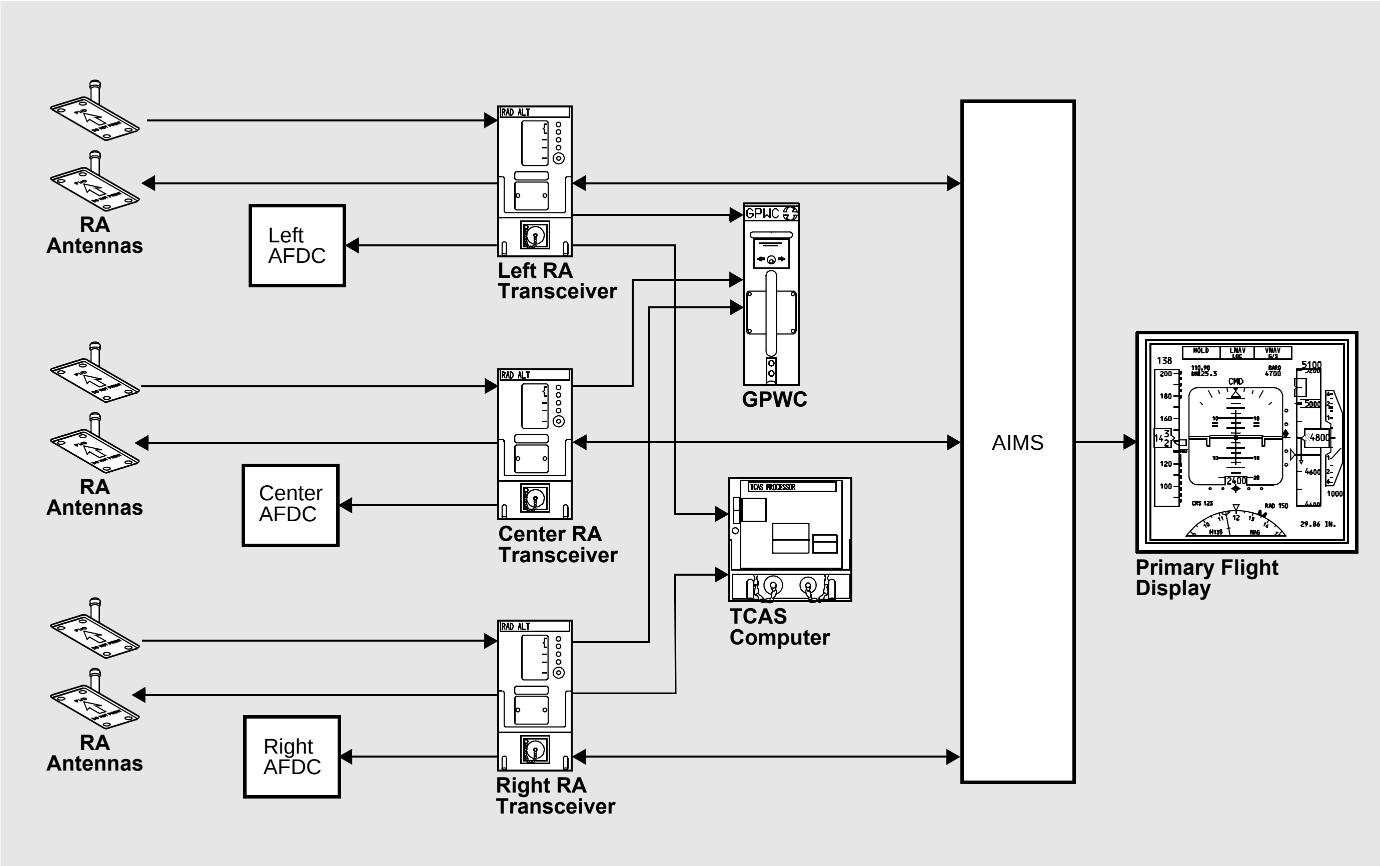
The GPS receiver is a card in the multi-mode receivers (MMR).

The ADIRU supplies inertial reference position and air data parameters, through the data conversion gateway function of AIMS, to the GPS. The GPS uses these parameters to find the best satellites during system initialization.

The ADIRS uses GPS position data to aid in the automatic calibration of the inertial sensors in the ADIRU. This reduces ADIRU position drift as the airplane flies.

The FMCF uses GPS position as the prime source for the calculation of airplane position. It is also the source for accurate time.

The GPS reports faults and test results to the central maintenance computing function (CMCF) of AIMS.



Radio Altimeter System

Radio Altimeter System

The radio altimeter (RA) system supplies the pilots and airplane systems with altitude above the terrain. The system operates at low altitude (0 to 2,500 feet).

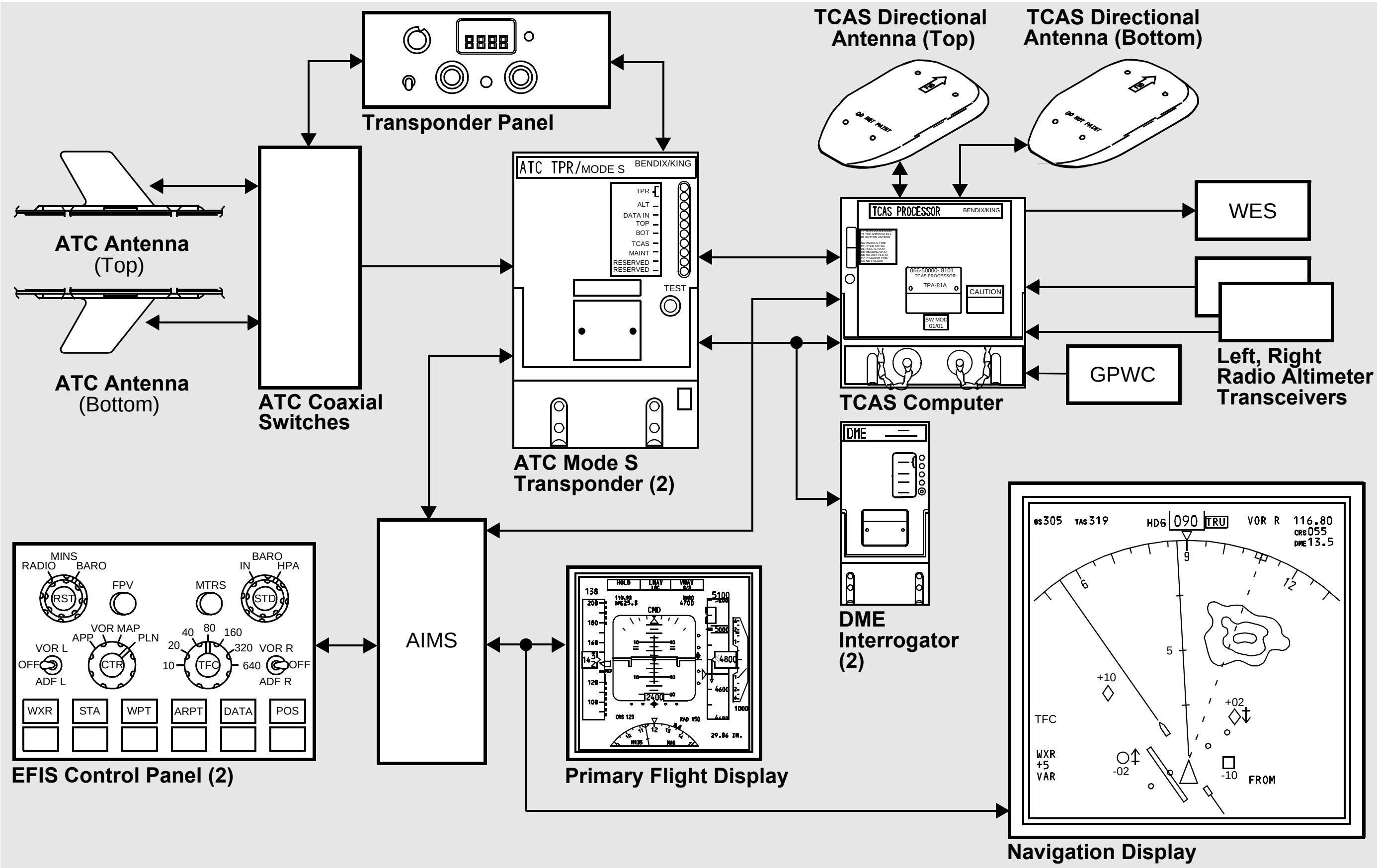
The system has three transceivers each with its own transmit and receive antennas. The transceivers calculate the radio altitude, which shows on the primary flight display (PFD).

Each pilot can select a radio minimums altitude on the onside EFIS control panel. The radio minimums show on the onside PFD above the radio altitude display. When the radio altitude is equal to or less than the radio minimums, the radio minimums display and the radio altitude change color and momentarily flash.

The RA system also supplies radio altitude data to these units:

- Autopilot flight director computers (AFDCs)
- Ground proximity warning computer (GPWC)
- Traffic alert and collision avoidance (TCAS) computer.

The central maintenance computer function (CMCF) of AIMS does a test of the RA system.



Air Traffic Control/Mode S System and Traffic Alert and Collision Avoidance System

ATC

The ATC/Mode S transponder system lets ground facilities monitor airplane movement through controlled airspace. The ground facilities monitor airplane location and altitude:

The transponder panel permits the flight crew to select the:

- Left or right ATC/Mode S transponder for operation
- Altitude reporting mode
- Airplane ATC identification code
- Initiation of the identification pulse.

The ATC/Mode S transponder gets ADIRS altitude data from AIMS and uses it for the altitude reporting function.

The ATC/Mode S system supplies suppression pulses to the DME interrogators and TCAS.

TCAS

TCAS gives alerts to the flight crew of possible collisions with other transponder airplanes. TCAS uses the ATC/Mode S transponder system to send TCAS data to other TCAS-equipped airplanes. TCAS gives two types of advisories to the flight crew. One type of advisory is the traffic advisory (TA) that gives indication of other airplanes in the area. The other type of advisory is the resolution advisory (RA). The RA gives an indication to the flight crew to change the direction of the airplane or hold the present course to prevent a possible collision.

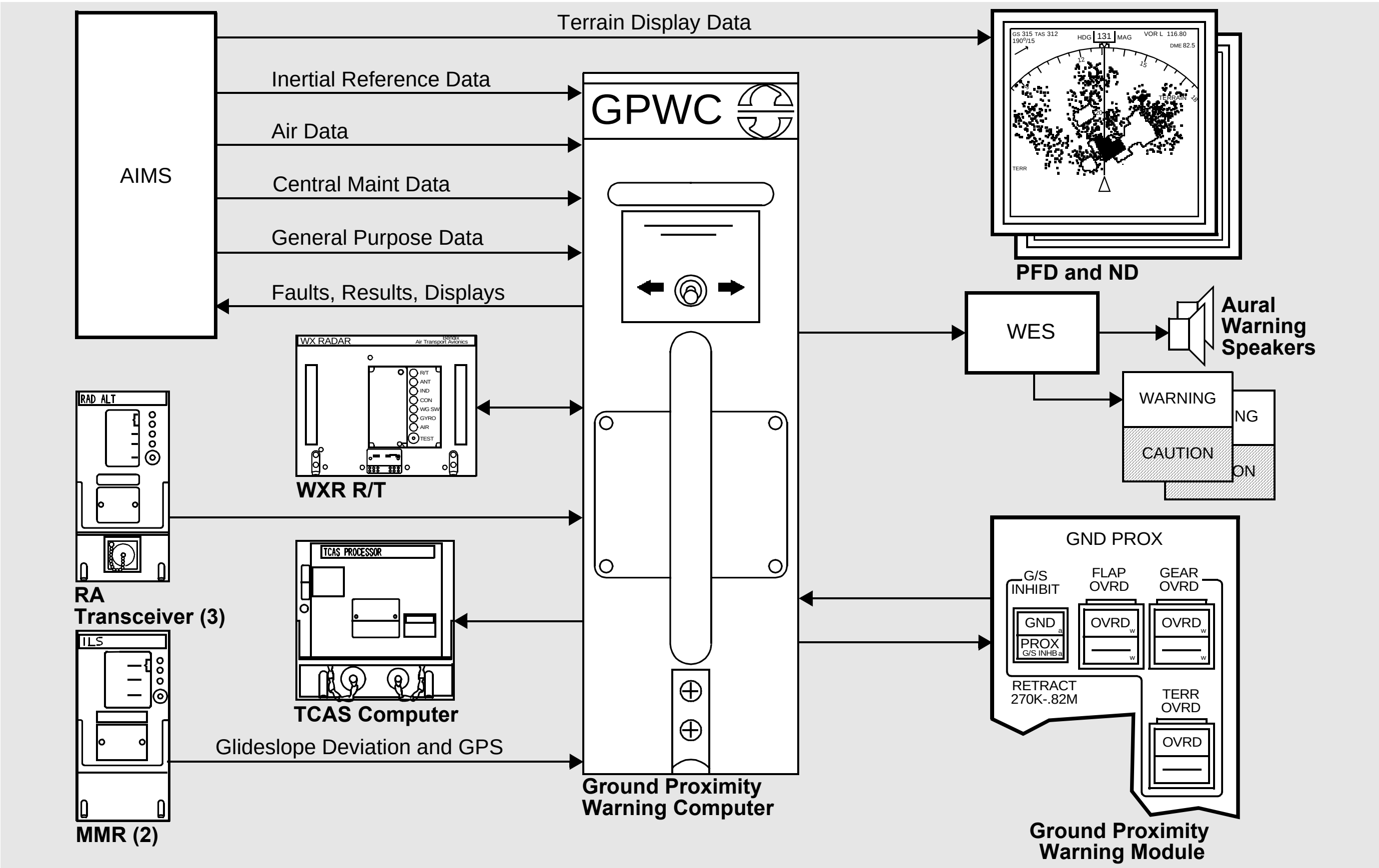
If an airplane is a collision threat, the TCAS computer selects the best maneuver to prevent a collision. If the other airplane has TCAS, a maneuver coordination is done through the ATC/Mode S data link.

The TCAS computer sends data to the NDs and the PFDs through AIMS. The traffic button on the EFIS control panel causes the location and track of other airplanes to show on the NDs. The PFDs show the flight crew how to change or hold vertical speed. Aural alerts come on in the flight deck through the WES.

TCAS antennas are on the top and bottom of the airplane. The antennas are directional.

Fault Reporting and Testing

The central maintenance computing function (CMCF) of AIMS supplies test and fault reporting functions for the ATC/Mode S transponder and TCAS systems.



Ground Proximity Warning System

Ground Proximity Warning System

The ground proximity warning system (GPWS) gives alerts or warnings to the flight crew of not safe terrain clearance. Alerts and warnings have aural and visual indications. These indications continue until the pilots correct the condition that started the warning or alert.

The GPWS uses these inputs to start alerts and warnings:

- AIMS - includes air data, inertial data, flight management data, central maintenance data, flap position, landing gear position, and stall warning data
- Instrument landing system
- Radio altimeter.

GPWS outputs go to these functions:

- AIMS - includes PFD and ND data and failure data
- GND PROX annunciator light
- Warning electronic system for audio amplification and control of the warning lights.

The GPWS supplies these prioritized modes when the airplane is between 30 and 2450 feet of radio altitude:

- Mode 1 - too much descent rate
- Mode 2 - too much terrain closure rate
- Mode 3 - too much descent after takeoff or go-around
- Mode 4 - not safe terrain clearance when not in the landing configuration
- Mode 5 - below glideslope deviation
- Mode 6 - radio altimeter aural callouts with gear down
- Mode 7 - windshear condition
- Terrain awareness mode
- Terrain clearance floor mode.

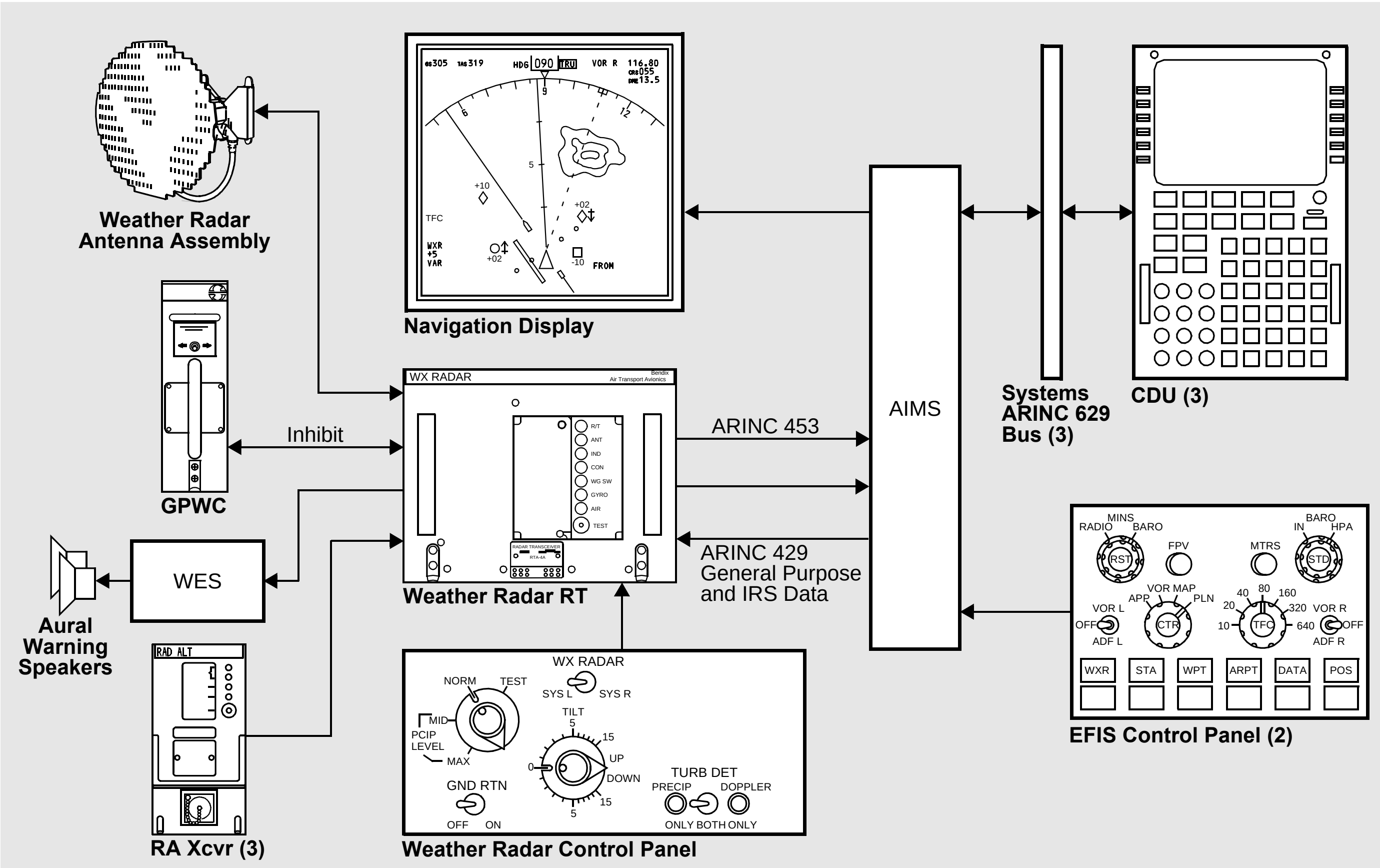
The system supplies voice warnings to help the pilots identify the cause of the warning or alert.

The guarded FLAP OVRD and GEAR OVRD switches prevent some modes. The FLAP OVRD switch gives a signal that is the same as flaps extended. The GEAR OVRD switch gives a signal that is the same as landing gear down.

The GPWS sends discretes to TCAS and to the WXR. These discretes put a priority on the warnings that can come from the three systems.

The terrain awareness mode uses a world-wide terrain data base to give warning of terrain proximity.

The terrain clearance floor mode uses data for the landing airport to make a safe approach.



Weather Radar System

Weather Radar System

The weather radar system shows the flight crew weather conditions along the flight path. This lets them change the flight path to go around bad weather conditions. The flight crew also uses the weather radar system as a navigational aid.

The weather radar receiver/transmitter (RT) sends weather display data to the AIMS on a ARINC 453 data bus. AIMS then shows a four-color weather display on the NDs.

The on-side EFIS control panel selects weather returns to show on the ND and also controls the range for the weather display.

The weather radar button on the EFIS control panel selects weather returns to show on the on-side ND.

The flight crew selects the operation mode, receiver gain, and antenna tilt angle on the weather radar panel.

When the flight crew selects the weather mode on the weather radar panel:

- Heavy rainfall shows in red
- Moderate rainfall shows in yellow
- Light rainfall shows in green
- In the turbulence mode, turbulence from heavy rainfall shows in magenta
- Windshear conditions show with a special symbol to give a warning to the flight crew.

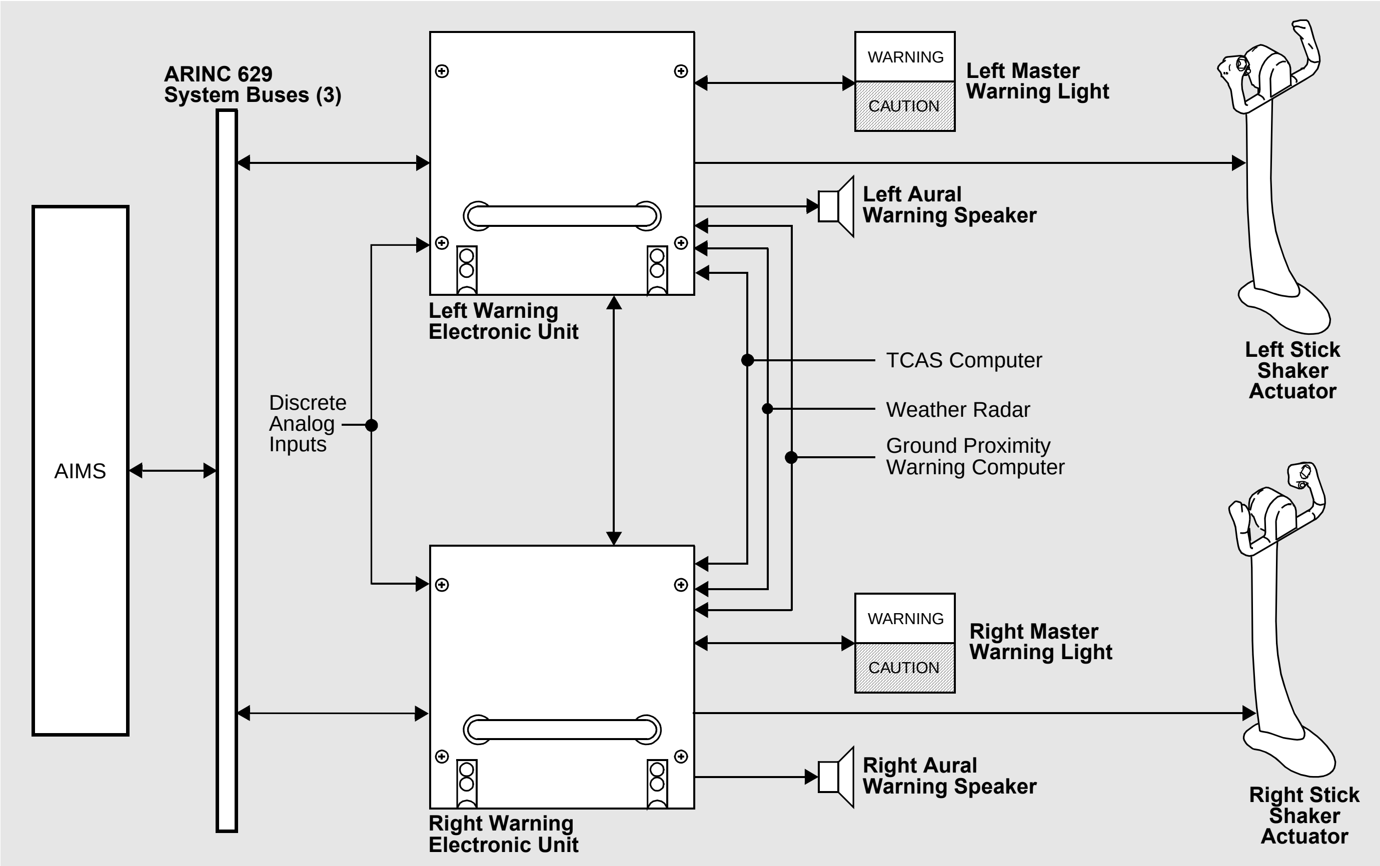
The map mode can show coastlines or large bodies of water.

Weather returns show on the ND in all EFIS modes but PLAN, full rose APPROACH, and full rose VOR.

The weather radar has a predictive windshear mode that can find conditions that cause a windshear. If it finds these conditions, it makes an aural warning and shows a special display on the ND. Because a windshear is most dangerous when the airplane is at low altitude, the weather radar comes on automatically on the ground during takeoff and when the airplane goes below 2200 feet during approach.

Antenna attitude stabilization is done by the ADIRS for horizontal scan.

You put the mode selector switch of the weather radar control panel in the TEST position to do a system test. The CMCF of AIMS stores weather radar system faults.



Warning Electronic System

Warning Electronic System

The warning electronic system (WES) supplies visual and aural indications of incorrect airplane system conditions to the flight crew. The system also turns on the stick shaker actuators when the airplane is near a stall condition.

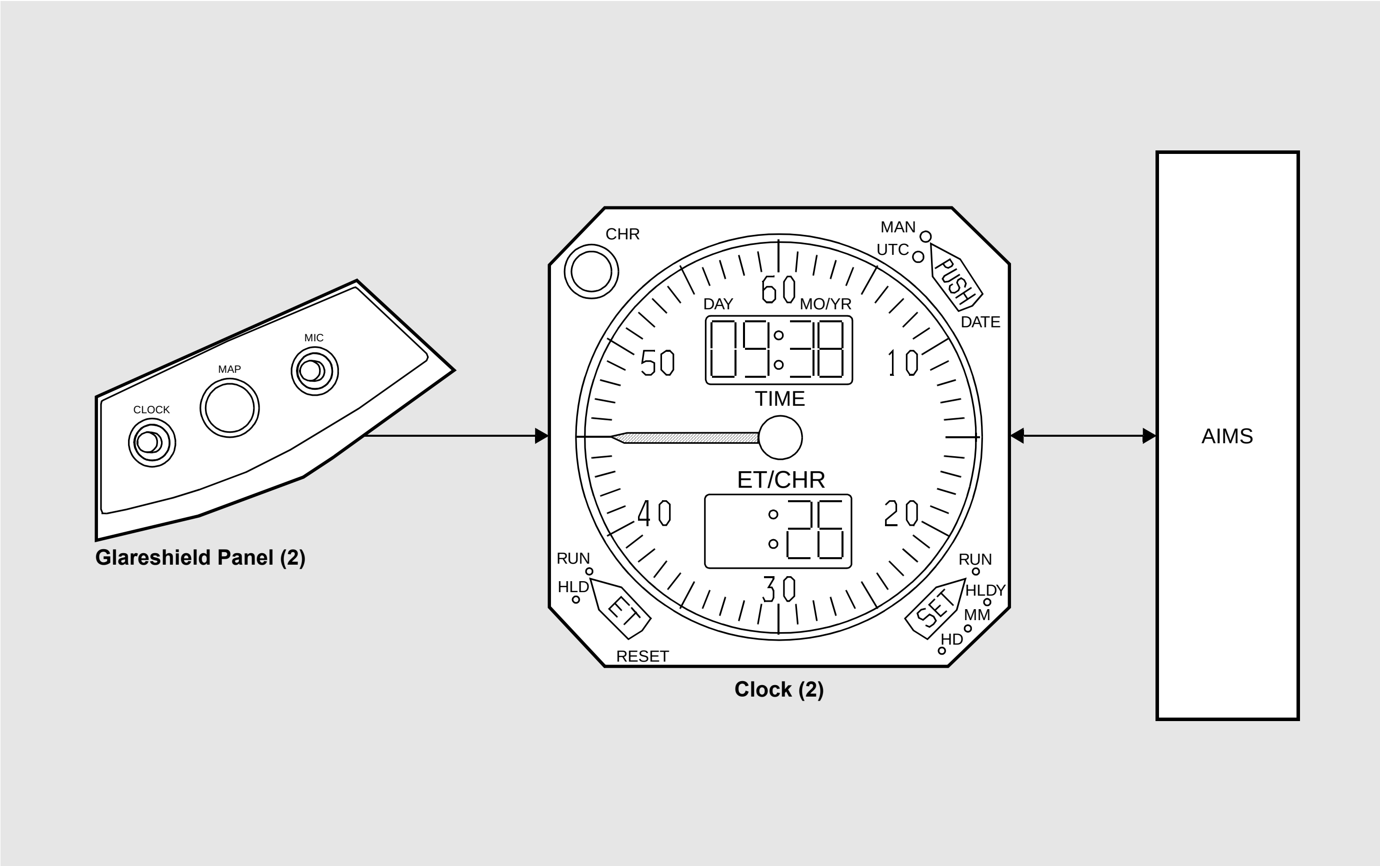
The system has two warning electronic units (WEUs). Each WEU has two internal channels. The channels do the same functions. The system receives inputs from sensors, airframe, and avionics systems. The ARINC 629 system buses supply most of the data.

WES performs these functions:

- Master warning lights control
- Landing and takeoff configuration warning
- Altitude alert
- Alert and warning aurals control and amplification
- Stall warning
- Speed tape parameters calculations
- Auto-slat deployment
- Stabilizer green band calculation and selection.

Outputs go to these:

- The aural warning speakers
- The master warning lights
- The stick shakers
- The AIMS for displays and maintenance functions.



Clock System

Clock System

There are two clocks in the flight deck, one on the captain and the other on the first officer instrument panel.

Each clock shows:

- Universal time (coordinated) (UTC)
- Date (Day, month, and year)
- Elapsed time in hours and minutes
- Chronograph time in minutes and seconds.

The airplane information management system (AIMS) receives clock UTC through ARINC 429 data buses.

The AIMS supplies global positioning system (GPS) time to the clock. The flight crew selects UTC manual input or GPS UTC time to show on the clock.

Autopilot Flight Director System

Features

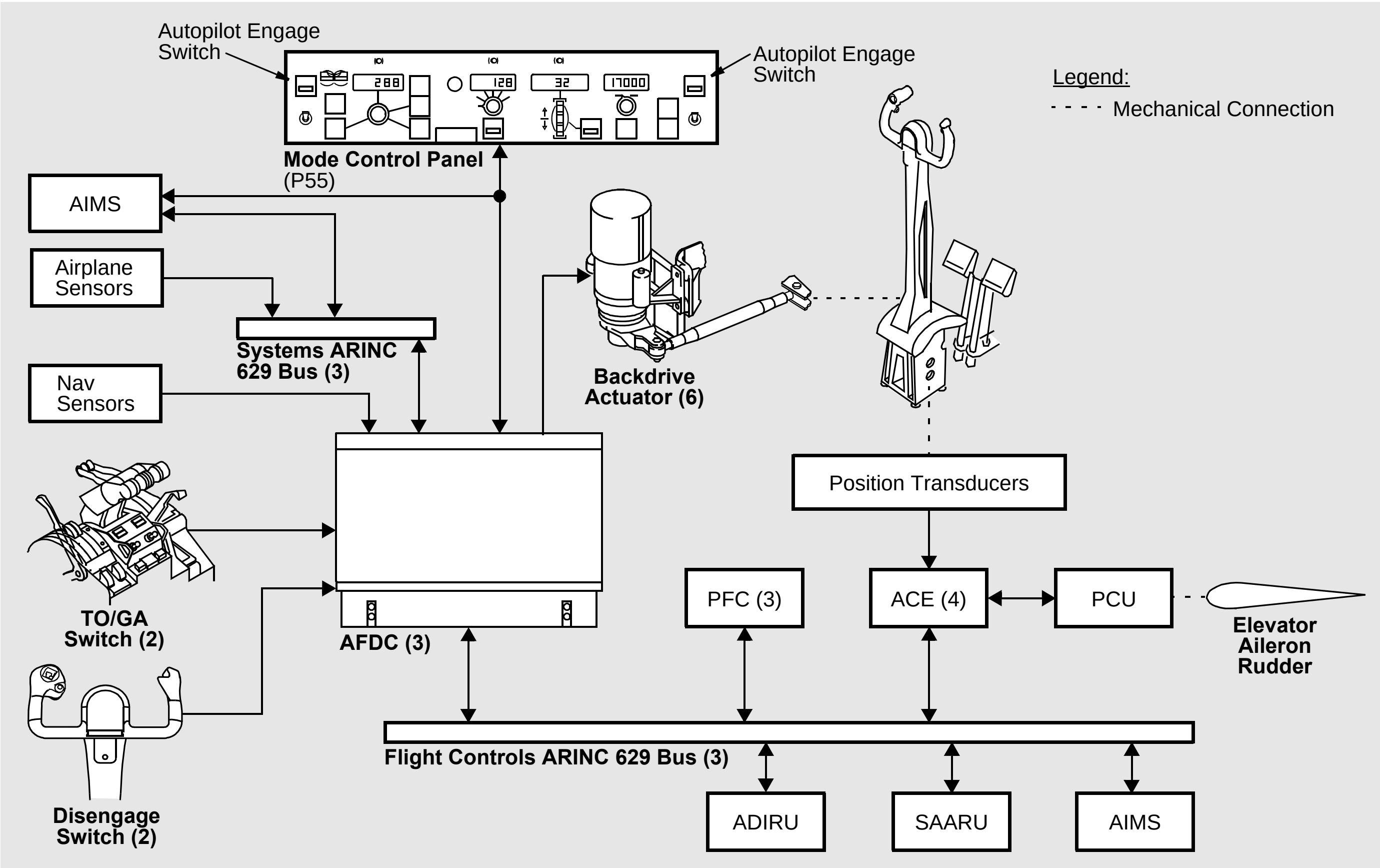
SYSTEM REDUNDANCY

The autopilot flight director system (AFDS) has three channels that supply automatic control of the airplane and flight director guidance. When selected, the system controls the airplane on the selected flight path and at the selected speed.

SIMILARITIES

The 777 autopilot flight director system is like the autoflight system on Boeing 757/767 and 747-400 airplanes.There are differences in the way the AFDS interfaces with the flight control system.

- **System Description**
- **Controls**
- **Indication**



AFDS Block Diagram

System Description

The autopilot automatically controls airplane heading, track, speed, altitude, navigation paths, and go-around. The flight director provides guidance commands for these functions plus for takeoff. The autopilot can do fail-operational and fail-passive approach and landings.

These are the AFDS components:

- One mode control panel (MCP)
- Three autopilot flight director computers (AFDCs)
- Six backdrive actuators
- Two control wheel disengage switches
- Two takeoff/go-around switches (TO/GA).

The AFDS does not have servos to move the primary flight control surfaces. The primary flight computers (PFCs), the actuator control electronics (ACEs), and power control units (PCUs) control the movement of the surfaces.

There are two autopilot engage switches on the MCP. All available autopilot channels engage when the flight crew pushes either switch.

The AFDS autopilot commands go to the PFCs through the flight controls ARINC 629 buses. The PFCs select which signal to use by mid-value selection.

The PFCs process and change the autopilot commands to surface commands that go to the ACEs and backdrive commands that go to the AFDCs.

The backdrive commands operate the backdrive actuators. The actuators move the control columns, control wheels, and rudder pedals to a position that represents the autopilot command.

Autopilot commands go to the rudder system only during automatic approach and landings.

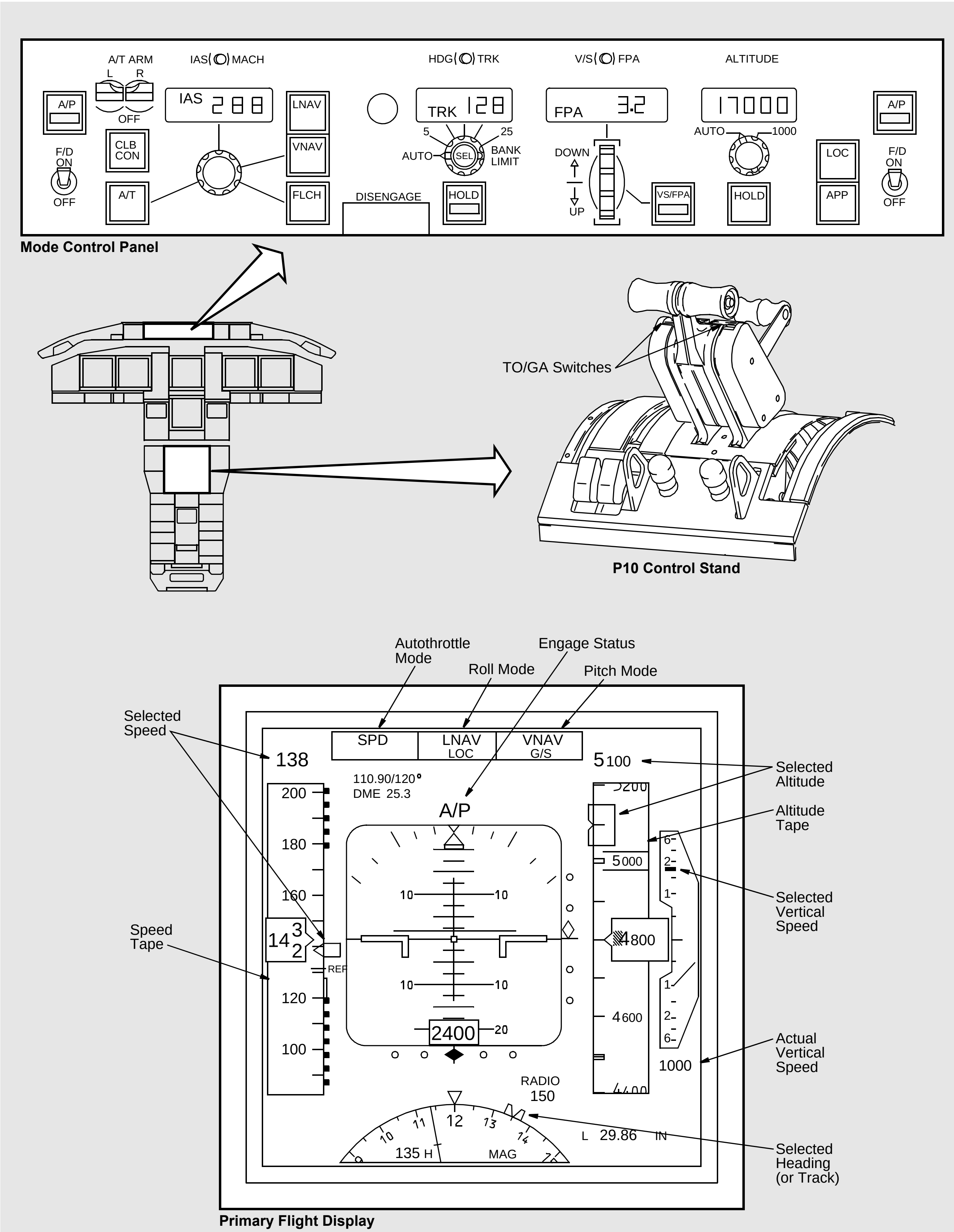
The AFDS does not control the horizontal stabilizer. Pitch trim control is from the primary flight control system.

Controls

Mode selection and engage switches for the autopilot, flight director, and autothrottle are on the MCP. The TOGA switches are on the thrust levers.

Indication

The PFDs show the AFDS selected values, mode annunciations, and AFDS status annunciations. Warning, caution, and advisory messages show on the EICAS.



Controls and Indications

Features

NO BREAK POWER TRANSFER

Two power sources momentarily supply power to the same bus (parallel sources) when a bus changes from one source to a source on the ground. This no-break power transfer decreases faults in electronic equipment.

THE ELECTRICAL LOAD MANAGEMENT SYSTEM (ELMS)

The ELMS controls the distribution of electrical power to the airplane. It also supplies control logic and indications for some airplane systems. ELMS replaces complex relay logic, discrete wiring, and circuit cards on other airplanes.

TWO EXTERNAL POWER CONNECTORS

There are two external power connectors on the 777. Each can receive 90 kVA of electrical power for ground operations.

BACKUP GENERATORS

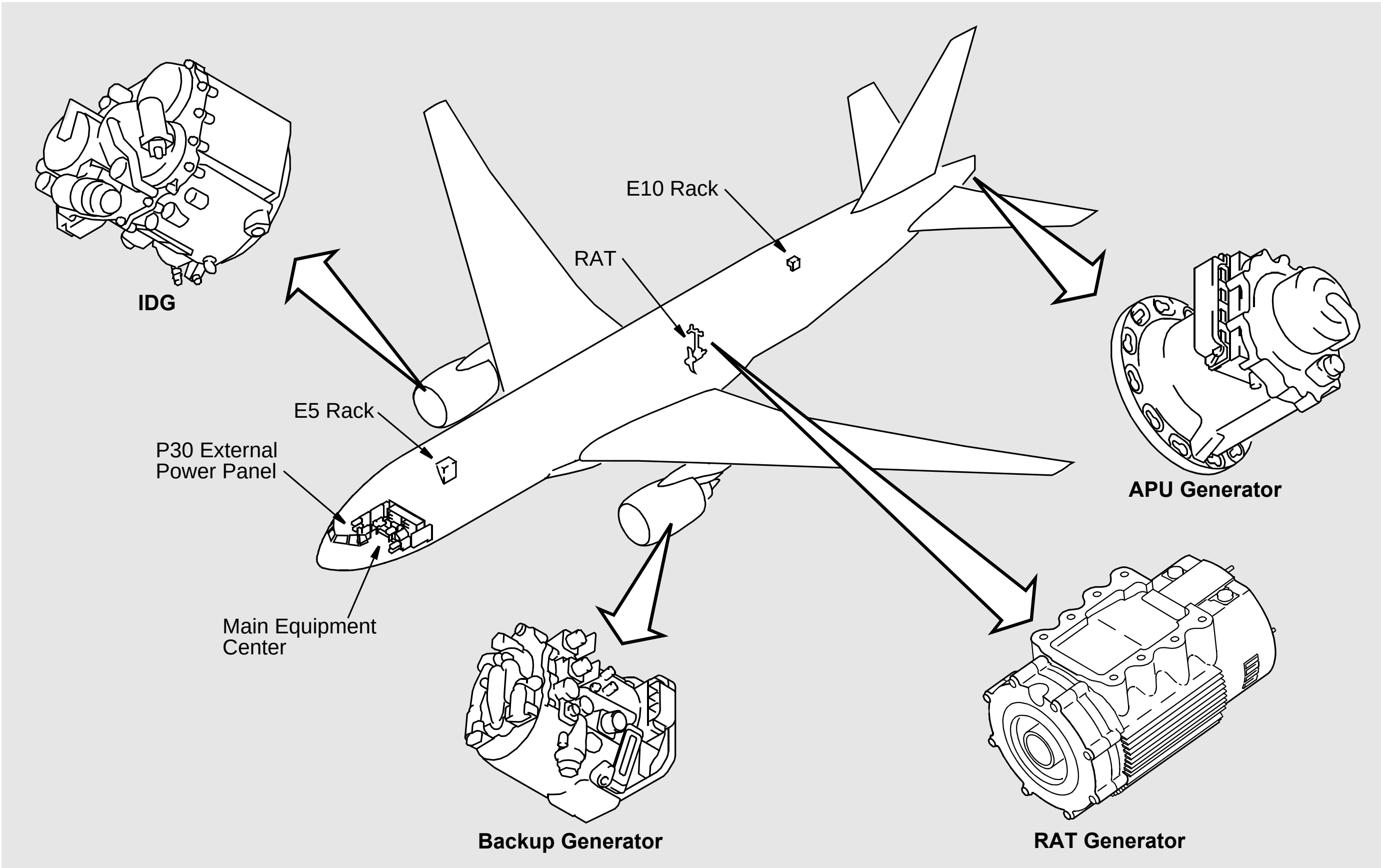
Each engine has a 20 kVA generator as a backup power source for the transfer buses that supply essential loads.

RAT GENERATOR

A ram air turbine (RAT) 7 kVA generator is a standby power source for the flight instrument buses.

SYNOPTIC DISPLAY

The electrical power synoptic display shows a real-time picture of the electrical power system configuration.



Electrical Power System Components

Electrical Power System Components

The electrical power system supplies 115 volt ac and 28 volt dc electrical power to the airplane. These are the power sources:

- Two integrated drive generators (IDGs)
- APU generator
- Two backup generators
- Ram air turbine (RAT) generator
- Main and APU batteries
- External power.

There is one IDG on each engine. They are the primary source of ac power in flight. An additional source of ac power is the APU generator. Each generator supplies up to 120 kVA.

There is one backup generator on each engine. They are variable speed variable frequency generators. Each supplies up to 20 kVA of ac power. A backup converter changes the variable frequency power to constant frequency power. Each backup generator also contains two permanent magnet generators (PMGs) that supply power to three flight control dc (FCDC) power supply assemblies.

A RAT generator is another source of backup ac power. It supplies up to 7 kVA.

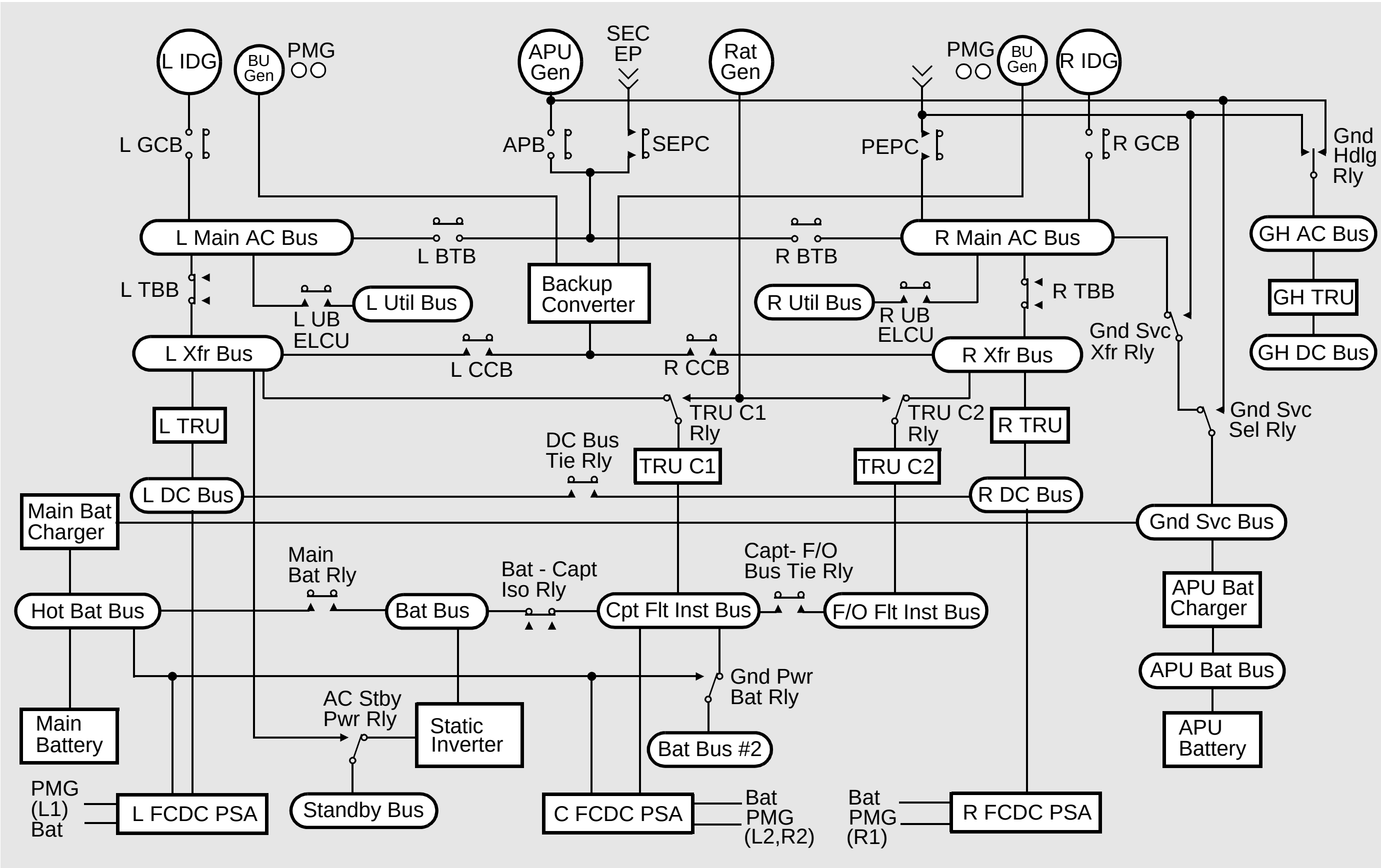
For ground operations, there are two external power connectors. These are on the forward, right side of the fuselage. Each external power connector is rated for 90 kVA of ac power.

These electrical system components are in the main equipment center:

- Generator control units (GCU) (4)
- Bus power control unit (BPCU)
- Backup converter
- Electrical load management system (ELMS) panels (7)
- FCDC power supply assemblies (PSA) (2)
- Transformer rectifier units (TRU) (5)
- Battery charger
- FCDC batteries (2).

One FCDC PSA and its related battery are in the E5 rack.

The main battery is in the main equipment center. The APU battery and charger are in the E10 rack. Both batteries supply 28 volt dc power.



Electrical Power System Schematic

Electrical Power System

The electrical power system normally operates as two independent left and right power channels. Each channel has a main ac bus. The twoft main ac buses get power from the onside IDG. Either main bus gets power from the APU generator or external power connections.

The right main ac bus supplies power to the ground service bus. When the right bus does not have power, the APU generator or primary external connector can supply power to the ground service bus.

On the ground, the APU generator or primary external power source supply power to the ground handling bus.

Five TRUs make 28 volt dc power from the ac power.

The hot battery bus and APU battery bus receive power from the ground service bus through the main and APU battery chargers.

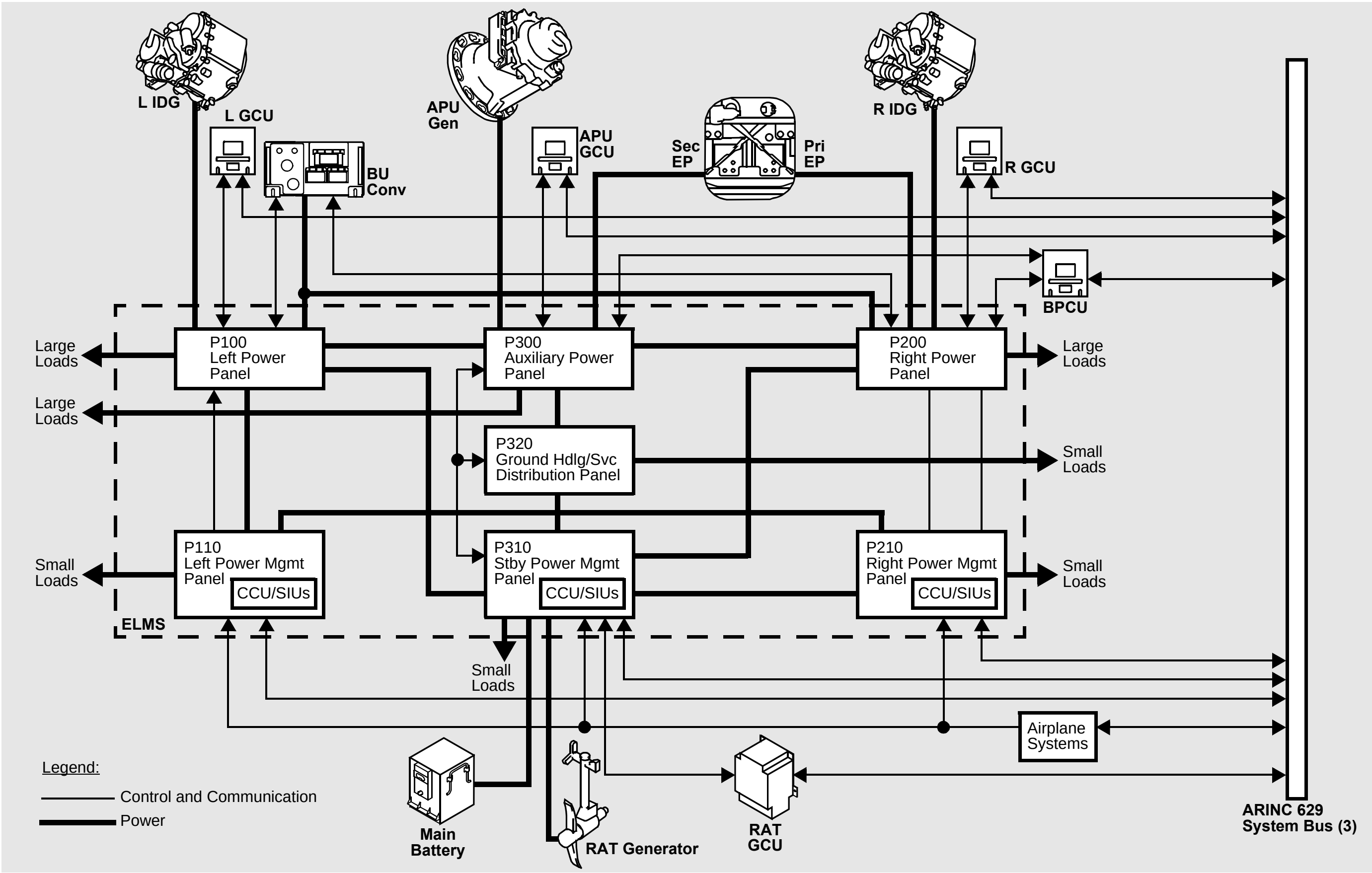
The standby bus normally receives power from the left main transfer bus. If no ac power is available, the standby inverter supplies power to the standby bus.

Backup generators operate when the engines are running. They supply power to the backup converter. If a main ac bus looses power, the converter supplies power to the related transfer bus. If the backup generators are not available, the RAT generator supplies power to the flight instrument buses.

Three FCDC PSAs receive power from the dc buses, hot battery bus, and PMGs in the backup generator. Small batteries prevent power interruptions during power transfers.

These are the acronyms for the components on this page:

- APB - auxiliary power breaker
- BTB - bus tie breaker
- BU - backup
- CCB - converter circuit breaker
- ELCU - electrical load control unit
- FCDC - flight control dc
- GCB - generator circuit breaker
- IDG - integrated drive generator
- PEPC - primary external power contactor
- PMG - permanent magnet generator
- PSA - power supply assembly
- RAT - ram air turbine
- SEPC - secondary external power contactor
- TBB - transfer bus breaker
- TRU - transformer rectifier unit
- UBR - utility bus relay
- XFR - transfer.



Electrical Power System Control

Electrical Power System Control

GCU AND BPCU CONTROL

The generator control units (GCUs) and bus power control unit (BPCU) monitor, give protection, and control switching for the main ac buses. The left and right GCUs control:

- Generator control relays (GCR)
- GCBs
- BTBs
- IDG voltage
- IDG frequency.

The APU GCU controls the APB and the APU voltage and frequency.

The bus power control unit controls:

- EPCs
- Ground handling relay
- Ground service select relay
- Ground service transfer relay.

BACKUP CONVERTER CONTROL

The backup converter monitors, gives protection, and controls the backup generators and power switching for the transfer buses. The backup converter controls the backup generator voltage, the TBBs, and the CCBs.

ELECTRICAL LOAD MANAGEMENT SYSTEM (ELMS)

The ELMS has seven panels for distribution, monitor, and protection of electrical power. The ELMS computers replace complex relay logic and circuit cards used on other airplanes. ELMS components are in the power panels and the power management panels.

POWER PANELS

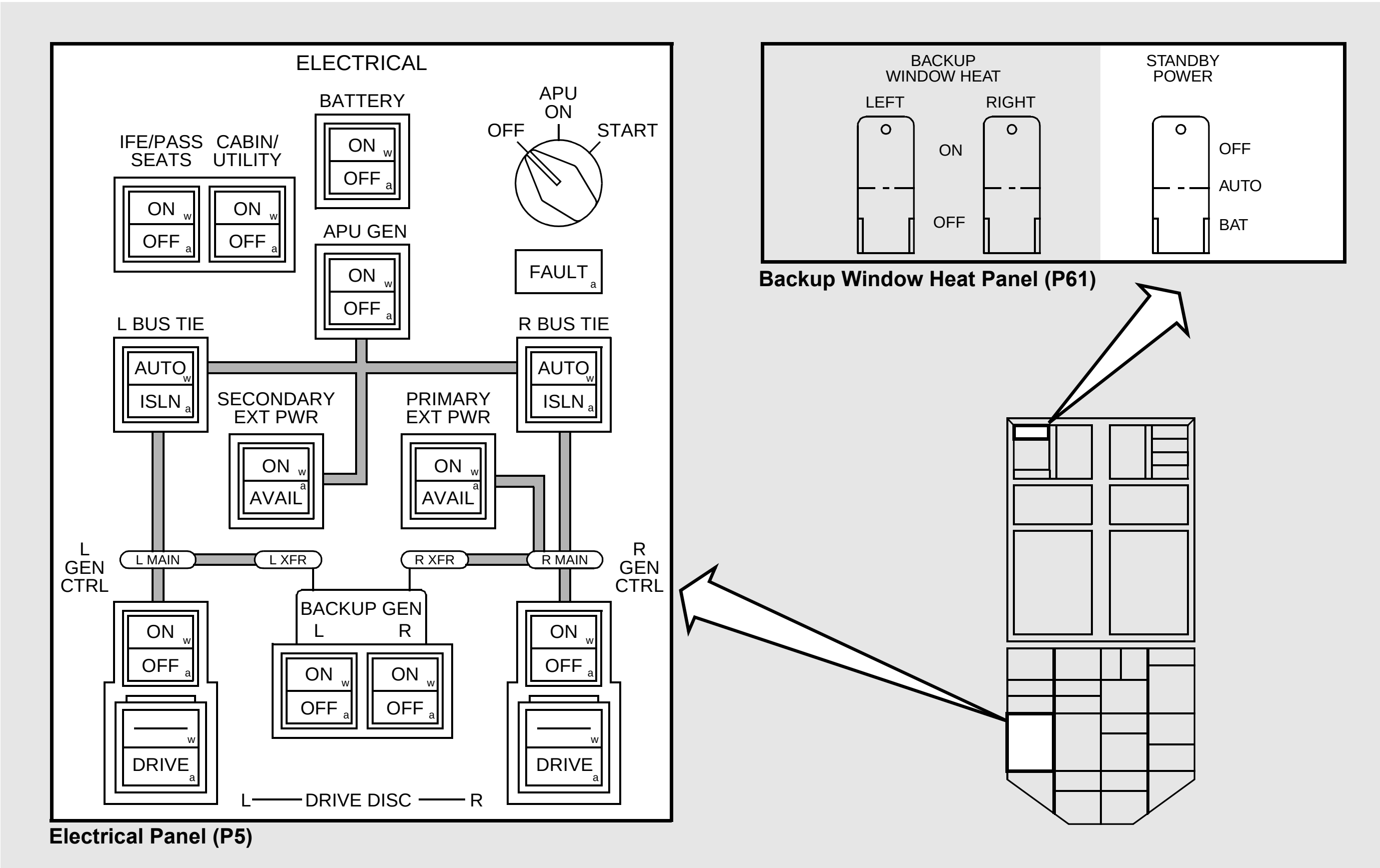
The three power panels receive power and send power to loads that use 20 amps or more. The main breakers and contactors are in the power panels. The GCUs and BPCU control these breakers and contactors.

POWER MANAGEMENT PANELS

The three power management panels send power to loads that use less than 20 amps. They have a computing and communications unit (CCU) and signal interface units (SIUs) that monitor loads and control many switching components in the seven ELMS panels.

GROUND SERVICE/HANDLING DISTRIBUTION PANEL

The ground service/handling distribution panel sends power to the ground handling and ground service buses. They do not have processors.



Controls and Indications

Controls and Indications

CONTROLS

The electrical power system control panel is on the P5 overhead panel. It includes controls and indications for these electrical system functions:

- Main battery
- IFE/passenger seats
- Cabin/utility
- APU generator
- Left and right bus tie
- Primary and secondary external power
- Left and right backup generator
- Left and right generator
- Left and right generator drive disconnect.

The panel also has the APU start selector.

A guarded, standby power switch is on the P61 overhead maintenance panel.

SYNOPTIC DISPLAY

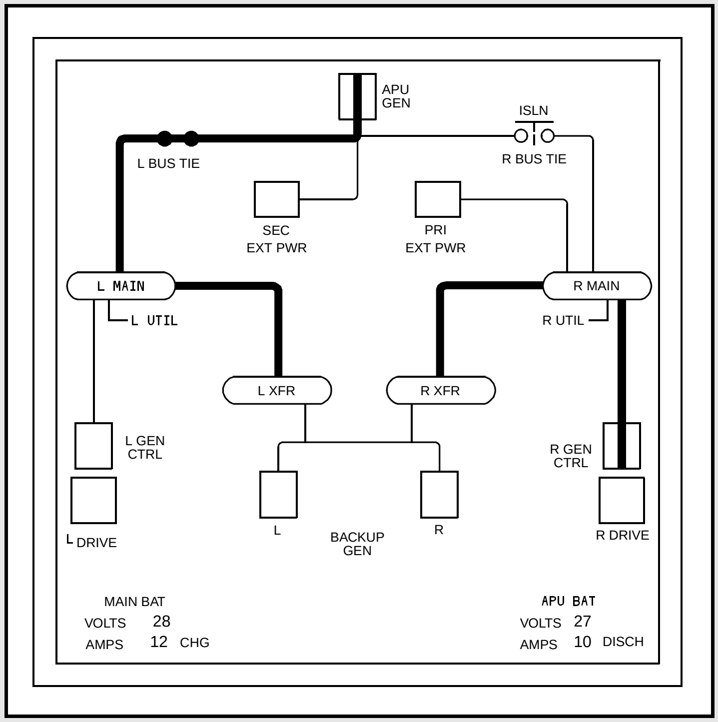
The electrical power synoptic display shows a real time summary of the electrical power system configuration. This synoptic has indications for these functions:

- IDGs
- APU generator
- Backup generators
- External power
- Bus tie breakers
- Main ac buses
- Transfer buses
- Main and APU batteries.

MAINTENANCE PAGE

The maintenance page shows electrical system data. This page includes these indications:

- AC and dc voltages
- AC frequencies
- AC loads
- DC currents
- Generator oil temperatures
- Oil level status
- Oil filter status
- Fly-by-wire (FBW) voltage and current.



Electrical Power Synoptic Display

Synoptic Display

ELECTRICAL PAGE 1/2

	L IDG	R IDG	APU GEN	PRI EXT PWR	SEC EXT PWR	BACKUP CONV	RAT GEN
AC-V	0	115	115	0	0	115	0
FREQ	0	400	400	0	0	400	0
LOAD	00.0	0.50	00.0	0.00	0.00	0.00	0.00

	MAIN BAT	L TRU	C1 TRU	C2 TRU	R TRU	APU/ BAT
DC-V	28	28	28	28	28	27
DC-A	12 CHG	25	12	11	30	10 DIS

	L IDG	R IDG	BACKUP L GEN	BACKUP R GEN	BACKUP CONV
OUT TEMP	27	57	25	62	33
RISE TEMP	3	12	1	14	--
OIL LEVEL	SERVICE	NORMAL	NORMAL	NORMAL	--
OIL FILTER	NORMAL	NORMAL	NORMAL	BLOCKED	--

	FBW L	FBW C	FBW R
DC-V	28	28	28
DC-A	14	15	15

DATE 20 AUG 96 UTC 18:54:04

Electrical Power Maintenance Page

Maintenance Page

Features

FUEL CAPACITY

One center tank and two main tanks hold 306,000 pounds (139,000 kg) in the 777-200ER and the 777-300. The 777-200 has a smaller center tank, so the airplane holds 209,000 pounds (94,700 kg). The 777-300ER holds 323,700 pounds (147,00 kg) with larger main and center tanks. The 777-200LR holds 361,250 pounds (164,200 kg) with auxiliary tanks.

FUEL TANK COMPONENT REPLACEMENT WITHOUT DEFUEL

Many fuel system components are removable from the rear spar without removal of fuel.

AUTOMATIC CENTER TANK SCAVENGE

When the fuel in the center tank gets low, the main tanks supply the engines. The remaining fuel in the center tank moves to the main tanks.

WATER SCAVENGE

Each tank has water scavenge pumps that operate continuously.

AUTOMATIC FUEL JETTISON SYSTEM

The fuel jettison system moves fuel overboard to decrease airplane gross weight. This prevents an overweight landing. The pilots start the jettison system operation. Operation stops at the maximum landing weight. The pilots can also manually select the quantity of fuel for jettison.

ULTRASONIC FUEL QUANTITY INDICATING SYSTEM (FQIS)

The FQIS uses an ultrasonic system and an advanced microprocessor to measure fuel quantity.

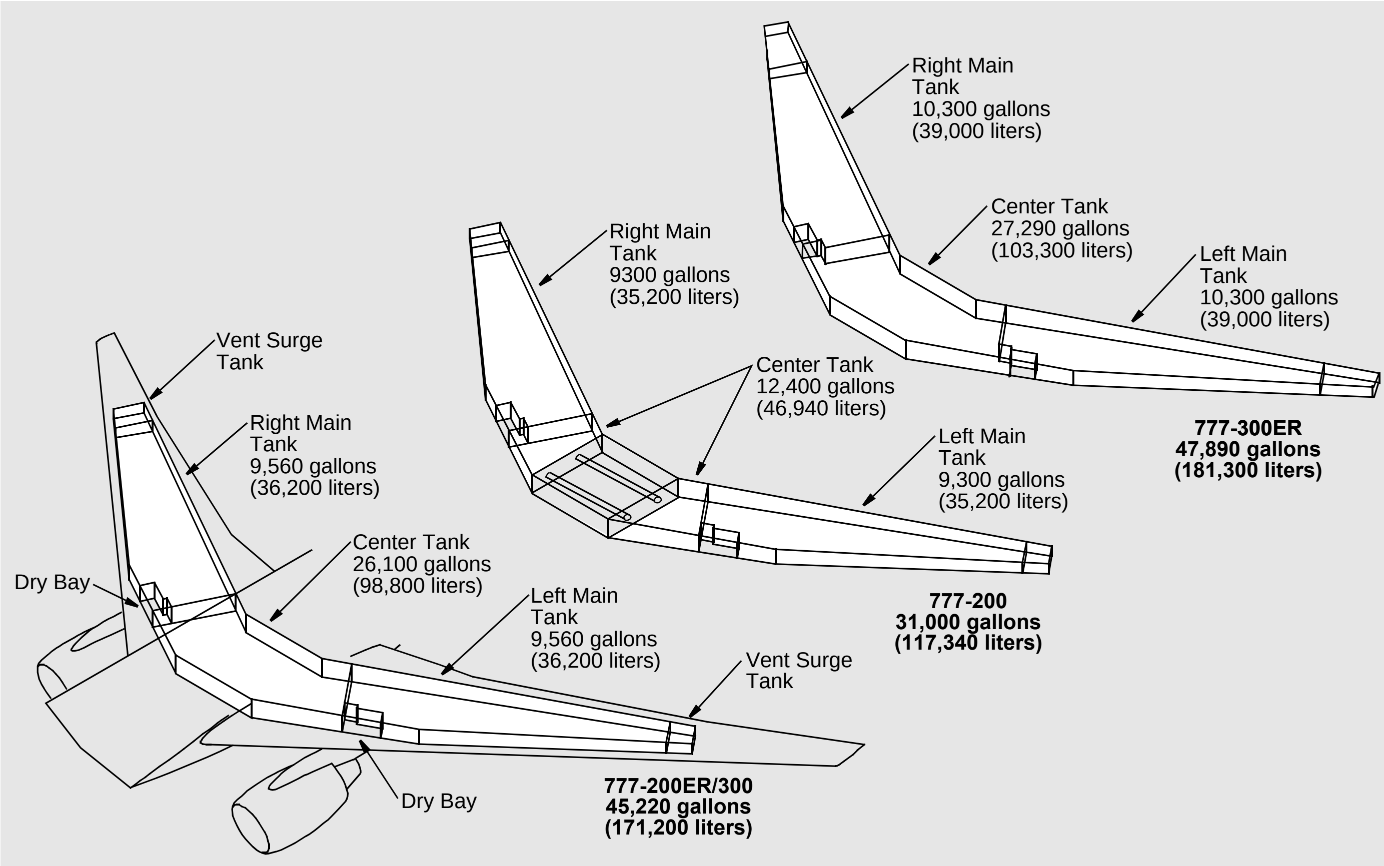
WATER DETECTION

Ultrasonic sensors find water in the bottom of a tank. The primary display system shows a maintenance page message as an alert to the ground crew of water in a tank.

FUEL SYSTEM SYNOPTIC DISPLAY

This synoptic display shows a schematic of the fuel feed system.

- **Fuel Tanks and Vent System**
- **Fuel Quantity Indicating System**
- **Pressure Refuel System**
- **Engine and APU Fuel Feed Systems**
- **Jettison and Defuel Systems**
- **Controls and Indications**



Fuel Tanks and Vent System

Fuel Tanks

The fuel system has three fuel tanks, two main tanks and one center tank. The tanks are part of the wing structure and the center wing section.

Most fuel system components are in the tanks. These are the components on the rear spar:

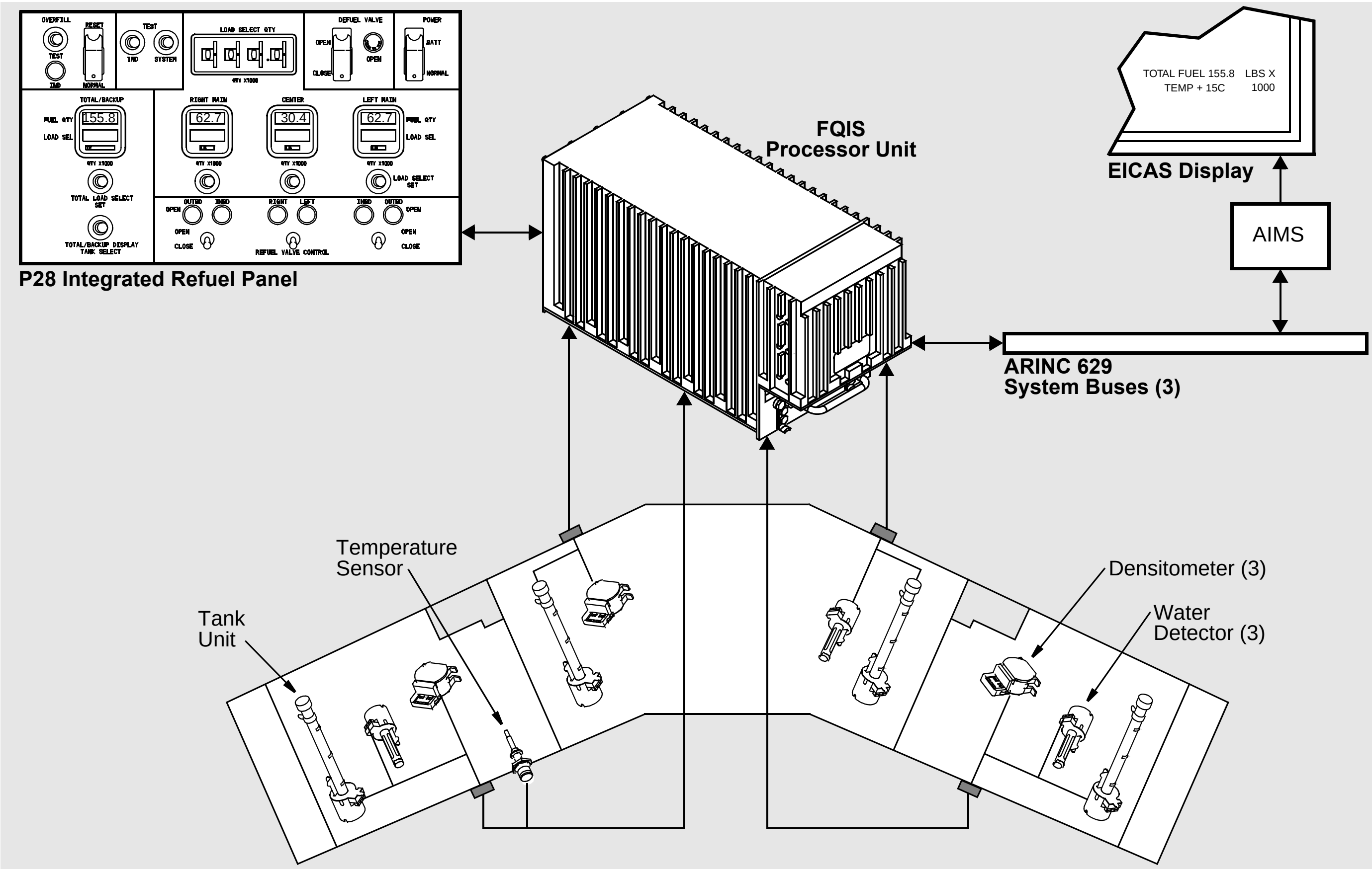
- Fuel pumps
- Scavenge jet pumps
- Valve actuators.

You can remove most of these components on the rear spar without the removal of fuel.

Fuel Vent System

The fuel vent system keeps the fuel tanks near ambient pressure during all flight phases, airplane attitudes, and refuel/defuel operations. Each fuel tank has a vent to its surge tank through channels in the wing.

The vent channels also let a fuel overflow go into the surge tank if necessary.



Fuel Quantity Indicating System

Fuel Quantity Indicating System (FQIS)

COMPONENTS

The fuel quantity indicating system (FQIS) does these functions:

- Measures the fuel quantity
- Calculates the fuel weight
- Controls fueling operations
- Shows when there is water in the tanks.

These are the FQIS components:

- Tank units
- Densitometers
- Wiring harnesses
- Water detectors
- FQIS processor unit.

The 777-200 has 52 tank units in the three tanks. The 777-200ER and -300 have 60 tank units. The 777-300ER has 76 tank units. Each tank unit is an ultrasonic transmitter/receiver that measures fuel height. The densitometers measure the fuel density in each tank. The wiring harnesses go from the tank units and densitometers to electrical connectors on the front and rear spars. Wiring from the connectors go to the processor.

OPERATION

The processor sends a signal to each tank unit to find the fuel height. The tank unit transmitter sends a sound pulse from the bottom of the tank to the fuel surface. The processor measures the fuel height by the time for the pulse to give a reflection back to the bottom. The processor uses fuel height to calculate the fuel volume and then multiplies fuel volume and density to calculate the fuel weight.

The processor sends fuel quantity data to the AIMS and the integrated refuel panel.

There is an ultrasonic water sensor at the bottom of each tank. They send a signal to the processor if there is water in the tank.

BITE

The processor has a different channel for each tank so that one fault does not cause loss of indication in more than one tank. Built-in test equipment (BITE) finds the FQIS faults and sends the data to the AIMS.

Controls and Indications

CONTROLS

Controls on the fuel management panel include:

- Forward and aft boost pump switches for each main tank
- Forward and aft crossfeed valve switches
- Left and right override/jettison pump switches for the center tank.

Fuel pump and crossfeed valve switch positions go through the ARINC 629 system buses to the ELMS. When the fuel pump switches are on, the ELMS supplies power to the pumps. When a valve switch is on, the ELMS supplies power to open the valve.

The ELMS monitors the pump pressure switches and valve positions. If there is a disagreement or fault, the ELMS turns on a light on the fuel management panel and sends fault data to the AIMS.

REFUEL SYSTEM CONTROL

Both the FQIS processor and the ELMS control refueling and defueling. The integrated refuel panel sends load select quantity, load select control, and valve switch positions to the FQIS processor. The processor stores the load select fuel quantity in memory. The processor sends valve switch positions to the ELMS through the ARINC 629 system buses. The ELMS supplies power to open and close the refuel or defuel valves.

ELMS monitors valve positions and sends them on ARINC 629 to the FQIS processor. The processor sends the valve position signal to the refuel panel for indication.

Surge tank overfill sensors send a signal through the IRP to the ELMS. If too much fuel is in the surge tank the ELMS removes power from the refuel valves to close the valves.

FUEL JETTISON CONTROL

Controls on the fuel jettison panel include:

- Left and right nozzle valve switches
- Fuel to remain selector
- ARM switch.

The ELMS monitors fuel jettison switch positions through the ARINC 629 system buses. When the jettison system is armed and at least one jettison nozzle valve is commanded open, the ELMS supplies power to the main tank jettison pumps and the jettison isolation valves.

The ELMS also calculates the maximum landing weight and time to complete jettison and sends them to the AIMS.

FUEL QUANTITY INDICATION

The EICAS display shows total fuel quantity. When the jettison system is operating, the EICAS display shows fuel to remain.

FUEL SYNOPTIC DISPLAY

The fuel synoptic display shows a schematic of the fuel system. This schematic shows the configuration of the fuel feed system. It includes this information:

- Fuel tank quantities
- Fuel pump on/off indication
- Fuel flow path
- Crossfeed valve positions
- Fuel valve positions.

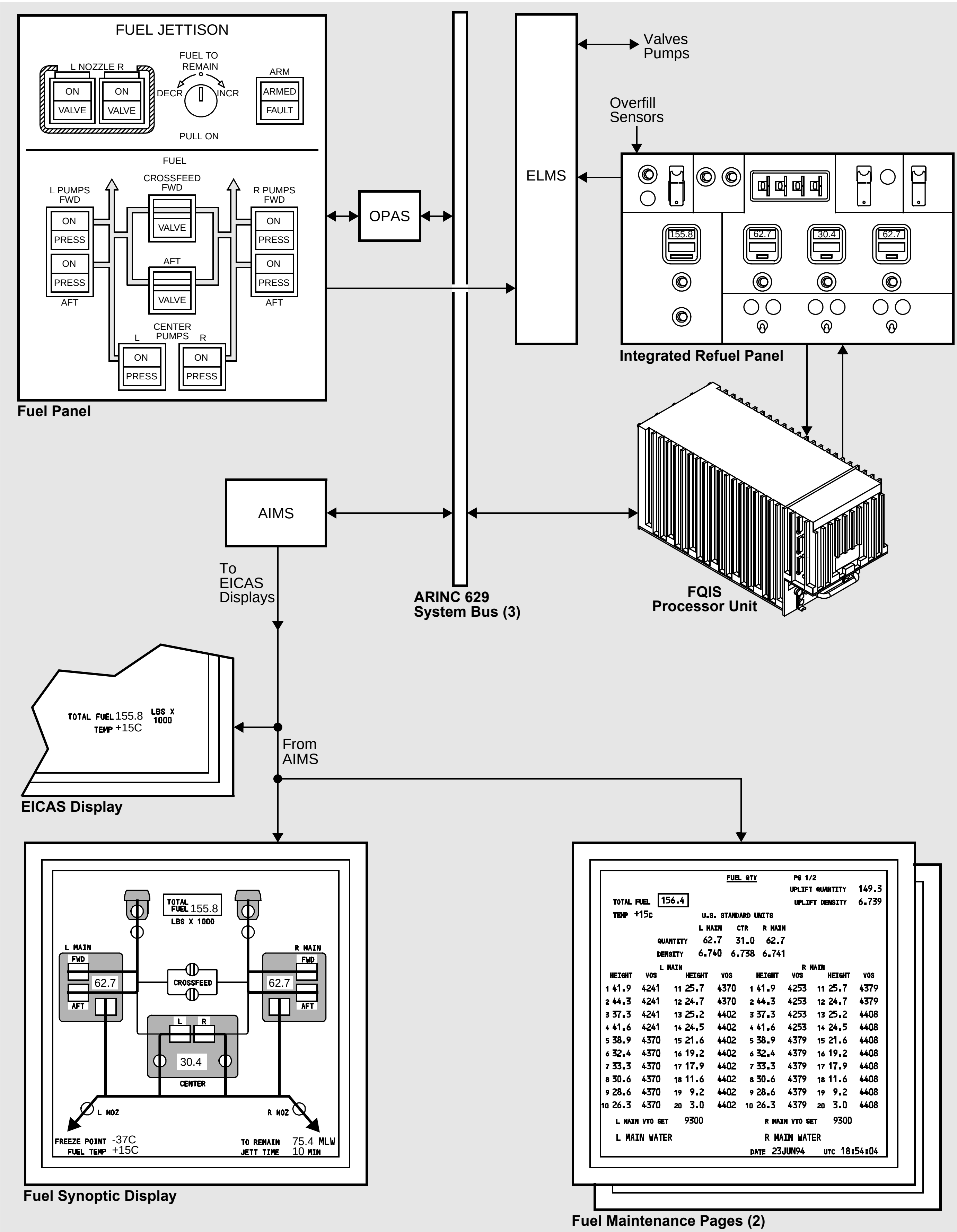
When the jettison system is in operation, the fuel synoptic display shows this information:

- Jettison pump on indication
- Isolation valve positions
- Jettison nozzle valve position
- Fuel to remain
- Jettison time.

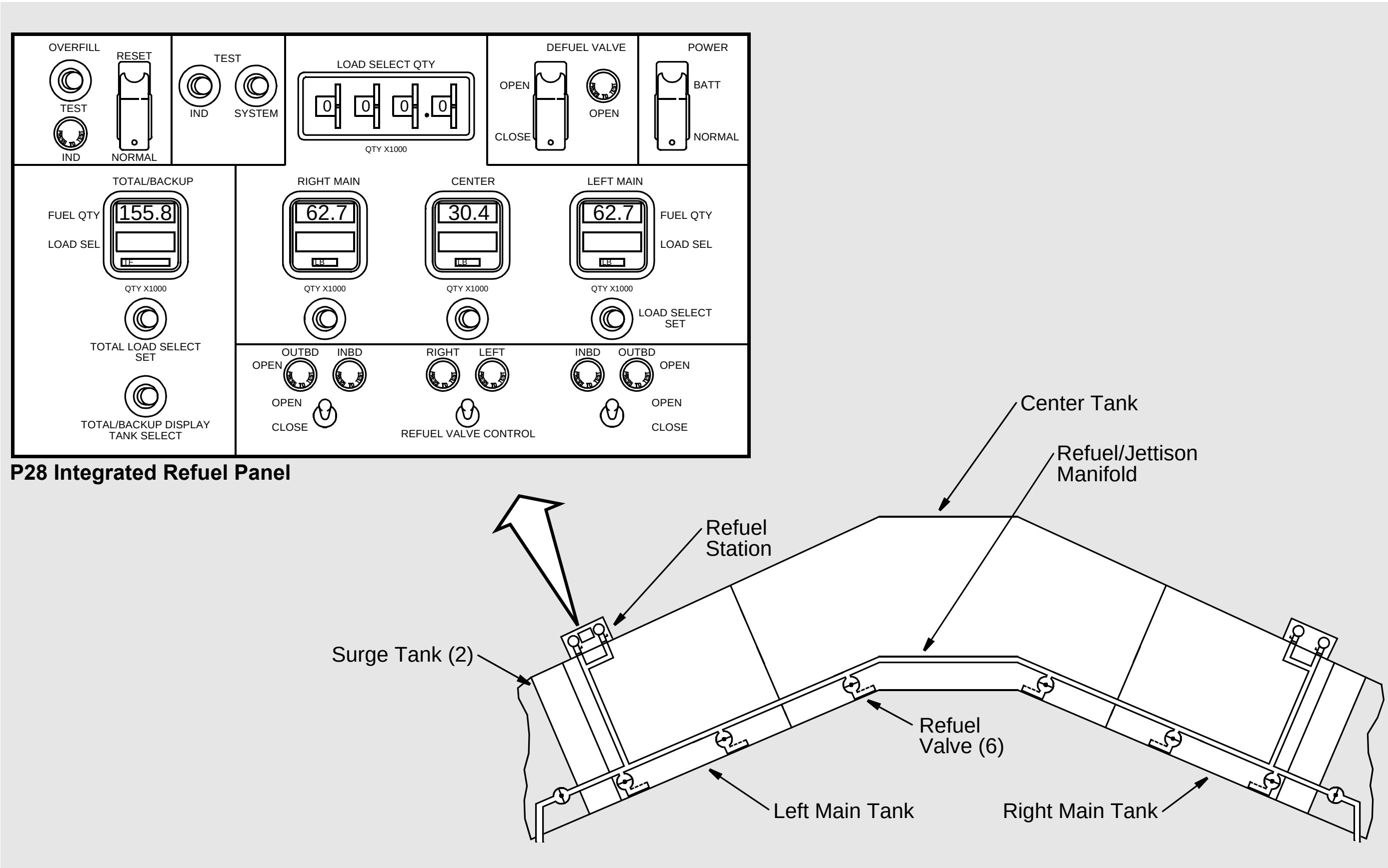
FUEL MANTENANCE PAGE

There is one fuel maintenance page for the left and right tanks, and one page for the center tank. The maintenance pages show this information:

- Fuel quantity
- Fuel density
- Maintenance messages
- Fuel height at each tank unit
- Velocity of sound at each tank unit.



Controls and Indications



Pressure Refuel System

Pressure Refuel System

The refuel station is on the leading edge of the left wing. It has two refuel adapters and an integrated refuel panel (IRP). A refuel station on the right wing is optional.

The integrated refuel panel has these components:

- Overfill test and reset switches
- Overfill indication light
- Indication and system test switches
- Load select quantity switches
- Defuel valve control switch
- Defuel valve position light
- Battery power switch
- LCD fuel quantity and load select indicators
- Load select set switches
- Display transfer switch
- Refuel valve position lights
- Refuel valve control switches.

There are six refuel valves, two for each main tank and two for the center tank. The fuel/jettison manifold supplies fuel from the refuel station to the valves. You can fill the tanks individually or all at the same time.

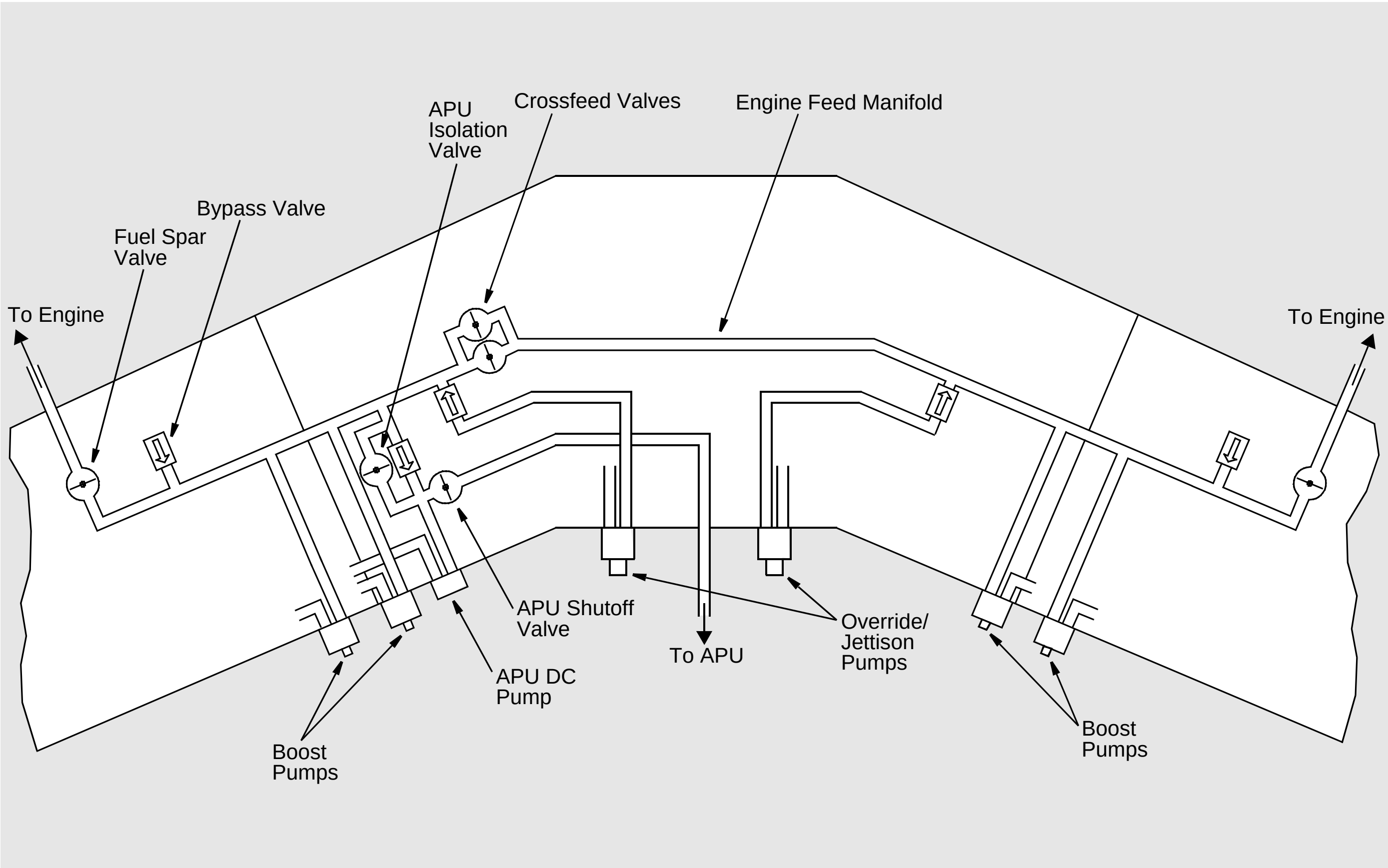
The control switches on the integrated refuel panel open and close the refuel valves. The valves also close automatically when one of these occur:

- Tank weight gets to a level set on the refuel control panel
- Tank gets to the volumetric shut off (VSO)
- Fuel flows into the surge tank
- You push the system test switch.

When you push the system test switch, the valves close and then open again automatically.

Power for the refuel system comes from the ground handling bus or the main battery. If electrical power is not available, you can not operate the valves manually.

Fuel measuring sticks permit manual fuel quantity measurement.



Engine and APU Fuel Feed Systems

Engine Fuel Feed System

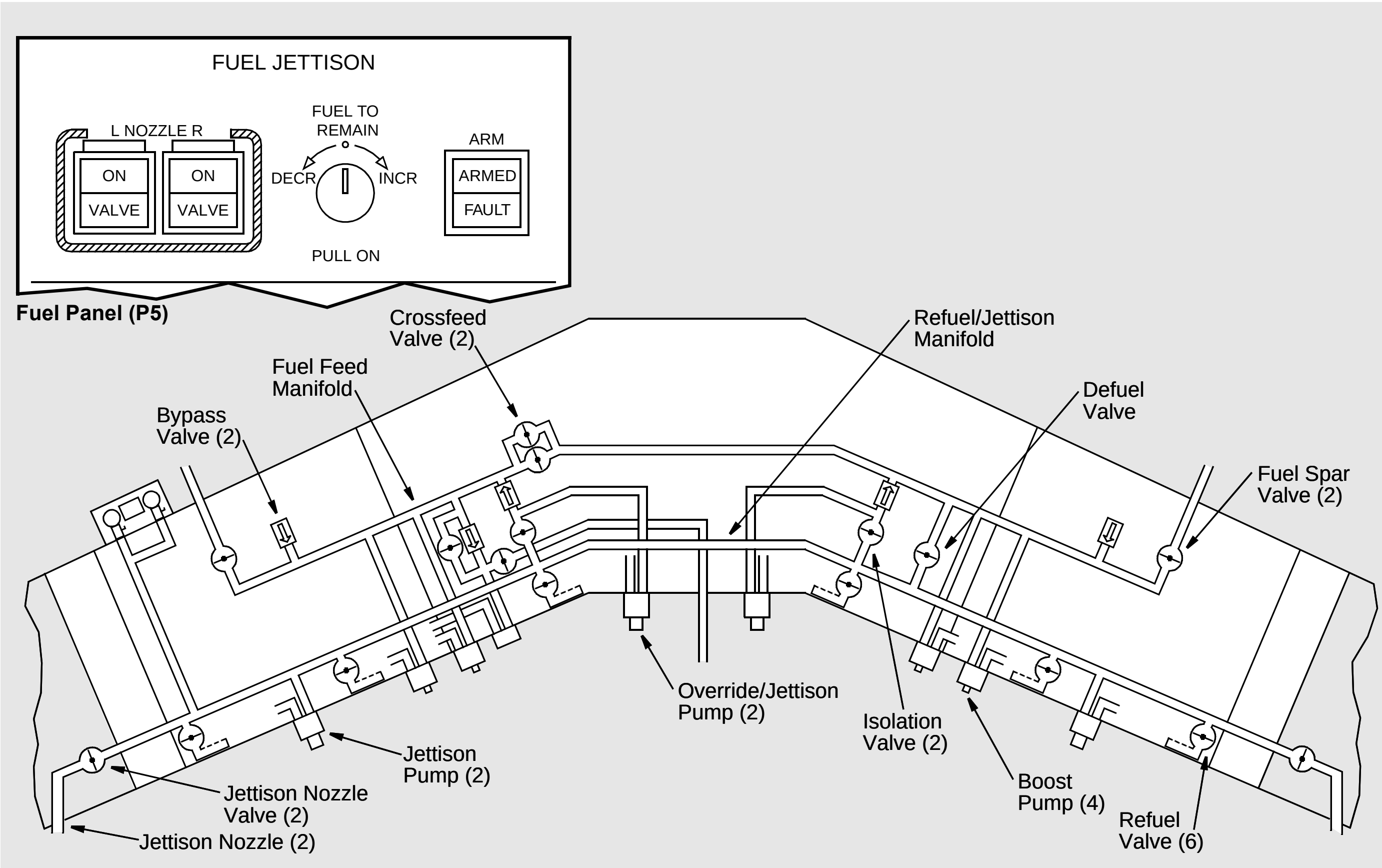
There are two boost pumps for each main tank and two override/jettison pumps in the center tank to supply fuel to the engines. The fuel flows through the crossfeed manifold to the engines. Redundant crossfeed valves isolate the left and right sides of the manifold.

At the start of a flight, when all the tanks are full, the normal procedure is to put on all the fuel pumps. The override/jettison pumps supply center tank fuel to the two engines. This occurs because the override/jettison pumps have a higher output pressure than the main tank boost pumps.

When the override/jettison pump output pressure decreases because of low fuel quantity in the center tank, the boost pumps automatically supply fuel to the two engines from the main tanks. The pilot puts off the override/jettison pumps. A scavenge jet pump moves the remaining center tank fuel to the main tanks.

APU Fuel Feed System

The APU can receive fuel from each tank. A dc pump supplies fuel from the left main tank if no ac power is available. When ground service ac power is available, the left forward boost pump automatically operates during an APU start.



Jettison and Defuel Systems

Jettison System

The fuel jettison system moves fuel overboard to decrease the landing weight. The system only operates in the air.

To operate the system, you set the ARM switch to ARM and the nozzle switches to ON. This opens the isolation valves, puts on the jettison pumps, and opens the jettison nozzles.

The jettison pumps put main tank fuel into the refuel/jettison manifold. The override/jettison pumps put center tank fuel into the fuel feed manifolds, through the isolation valve, and into the refuel/jettison manifold. The fuel goes overboard through the jettison nozzles.

Fuel quantity and jettison time show on EICAS and the fuel synoptic. The jettison system automatically goes off at the maximum landing weight (MLW). You can set the MLW up or down with the FUEL TO REMAIN switch.

Defuel System

The override/jettison and boost pumps put fuel into the engine feed manifold. You open the defuel valve from the refuel panel. Fuel goes through the defuel valve, the refuel/jettison manifold, and the refuel panel adapters into a ground container.

FUEL TRANSFER

You use the boost pumps and the defuel, crossfeed, and refuel valves for a tank-to-tank transfer on the ground.

Features

ENGINE

The GE90 - 90 series is a high bypass turbofan engine with a 123-inch (3.12-meter) fan diameter. The GE90 - 100 series is a growth version of the - 90 series with a 128-inch (3.25-meter) fan diameter.

POWERED DOOR OPENING SYSTEM

The fan cowls and thrust reverser assemblies have a powered door opening system for easy operation.

EGT PYROMETER (-90 SERIES)

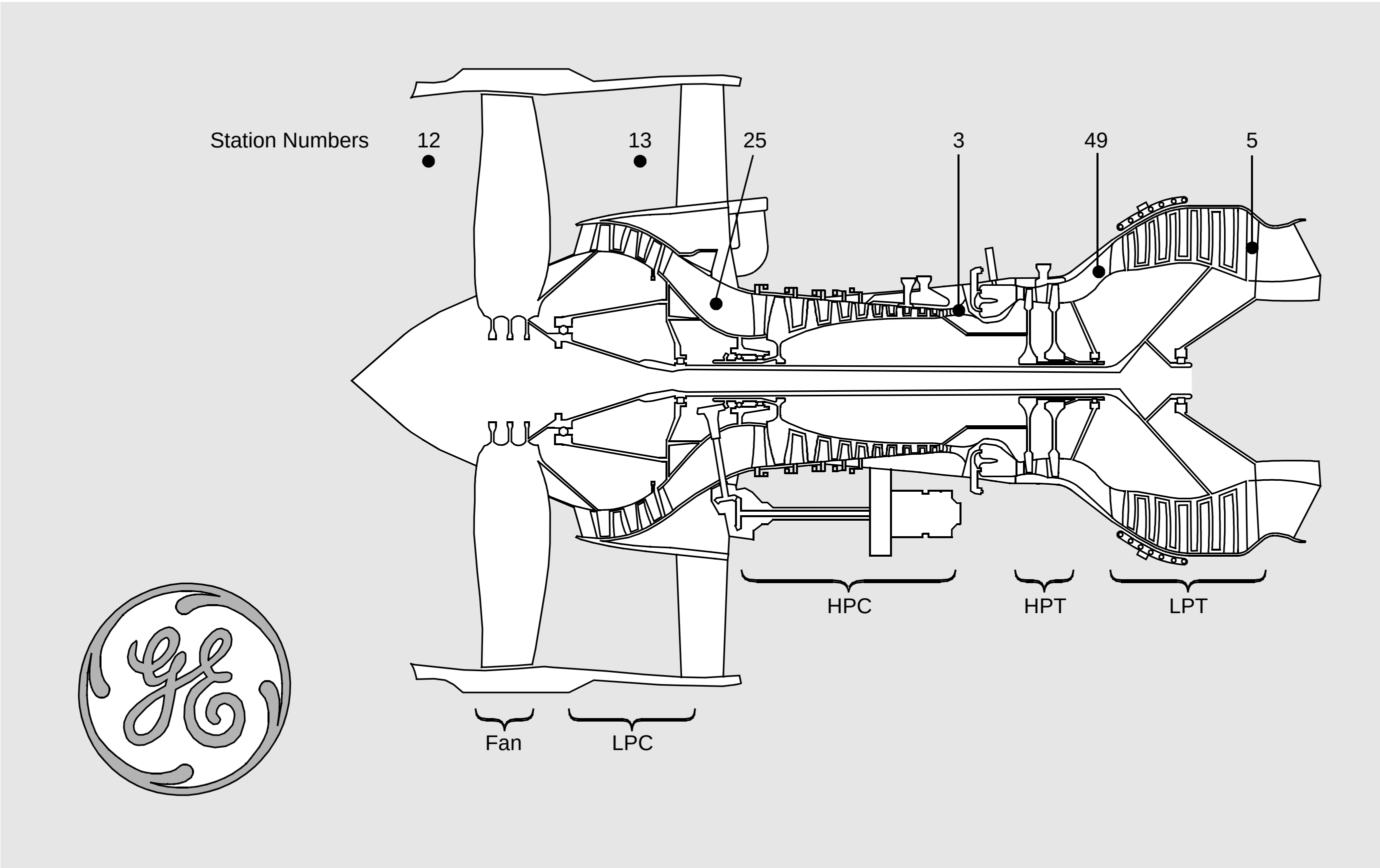
An EGT pyrometer uses an infrared sensor to measure turbine blade metal temperature.

DUAL ANNULAR COMBUSTOR AND DUAL TIP SPRAY NOZZLES

Each fuel nozzle assembly has two spray nozzles on it for the dual annular combustor. This combustor design gives efficient combustion with decreased emissions.

DEBRIS MONITORING SYSTEM

An electronic chip detector monitors the engine oil system for ferrous contamination.



Engine Specifications

GE90

The GE90 engine is a high bypass ratio, two-spool turbofan engine. The low pressure shaft (N1) has these components:

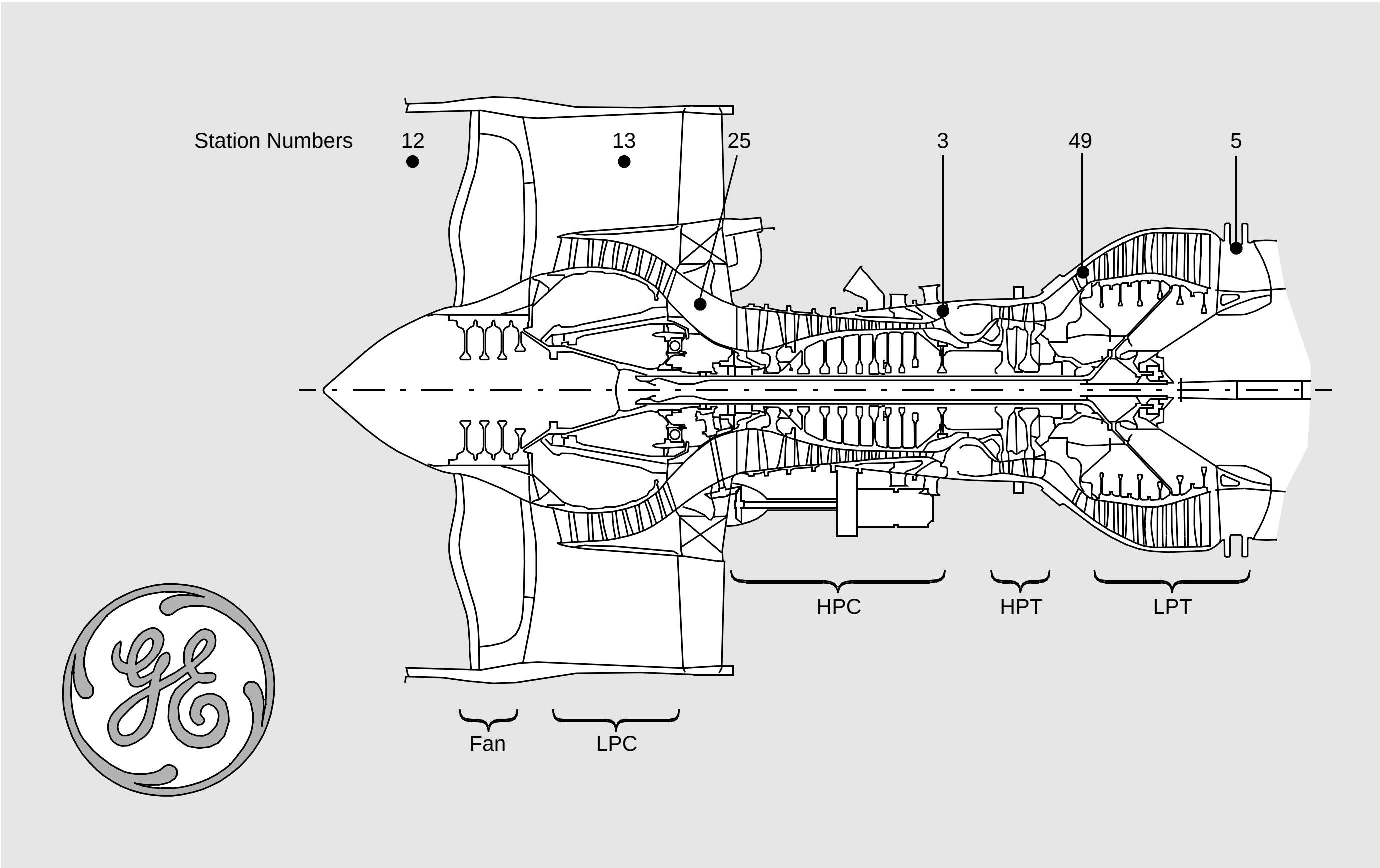
- 123-inch (3.12m) fan
- Three-stage low pressure compressor (LPC or booster)
- Six-stage low pressure turbine (LPT).

The high pressure shaft (N2) has these components:

- Ten-stage high pressure compressor (HPC)
- Two-stage high pressure turbine (HPT).

The GE90 engines have different takeoff thrust ratings. Software pin programming in the electronic engine control (EEC) changes the ratings.

Most of the engine line replaceable units (LRUs) attach to the core of the engine or the gearbox. You open the thrust reverser assembly to get access to these components. Some LRUs attach to the fan case and you open the fan cowls to get to them.



Engine Specifications

GE90-100 Series

The GE90-115/110 engine is a growth version of the GE90-90 series engine for the 777-300ER/200LR. The low pressure shaft (N1) has these components:

- 128-inch (3.25 m) fan
- Four-stage low pressure compressor (LPC or booster)
- Six-stage low pressure turbine (LPT).

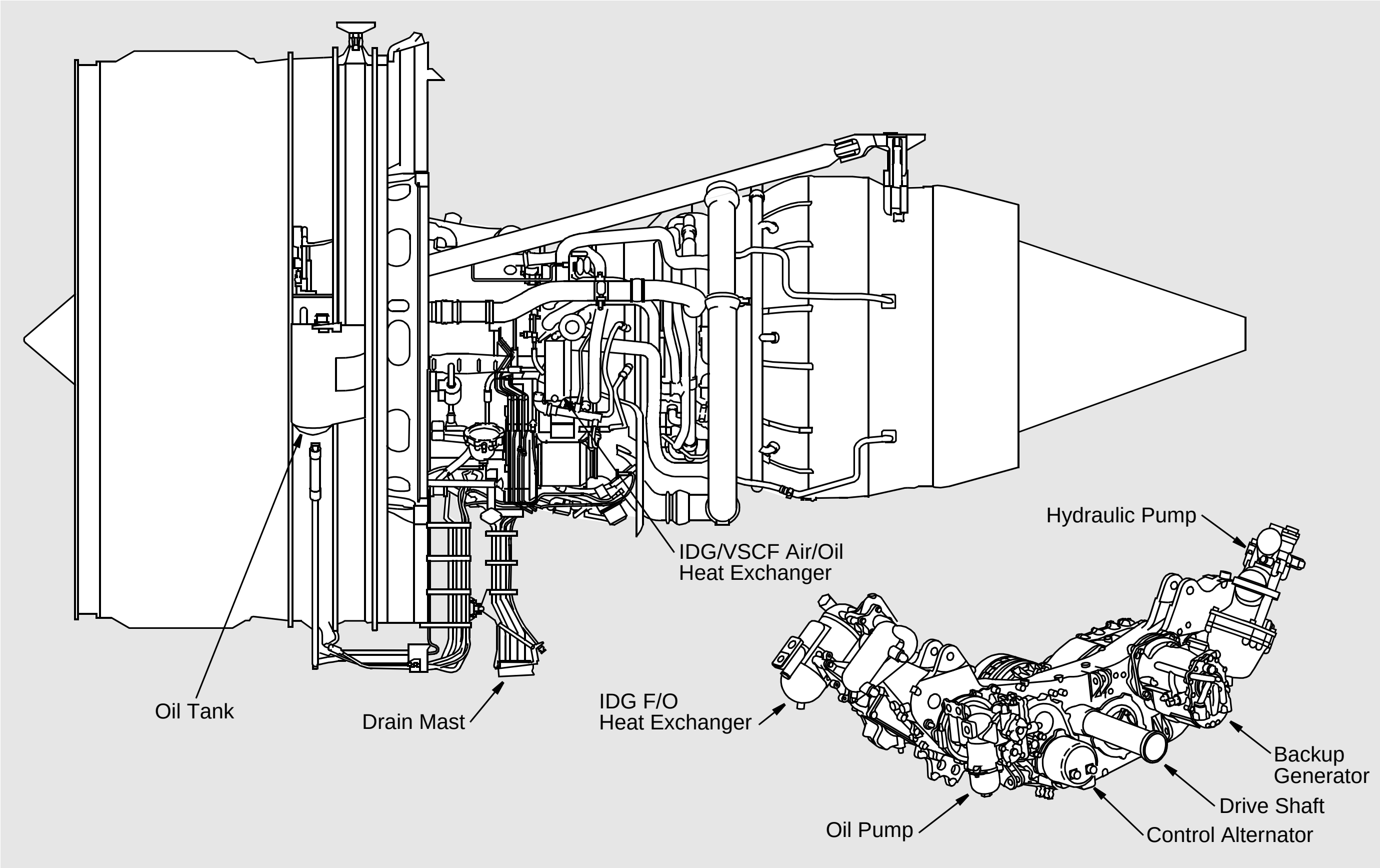
The high pressure shaft (N2) has these components:

- Nine-stage high pressure compressor (HPC)
- Two-stage high pressure turbine (HPT).

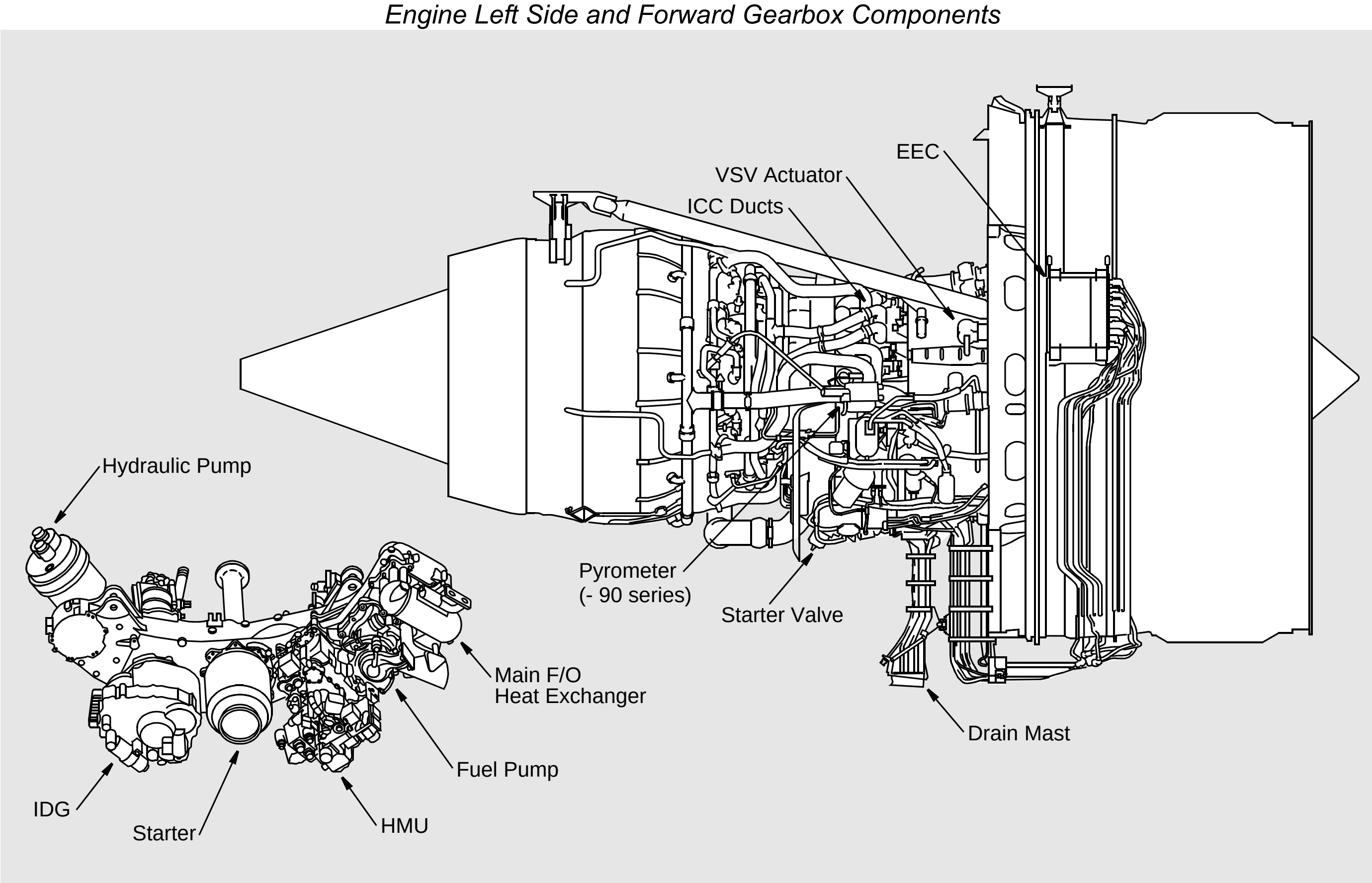
The GE90-115 engines have a different takeoff thrust rating for the 777-200LR. Software pin programming in the electronic engine control (EEC) changes the ratings.

Most of the engine line replaceable units (LRUs) attach to the core of the engine or the gearbox. You open the thrust reverser assembly to get access to these components. Some LRUs attach to the fan case, and you open the fan cowls to get to them.

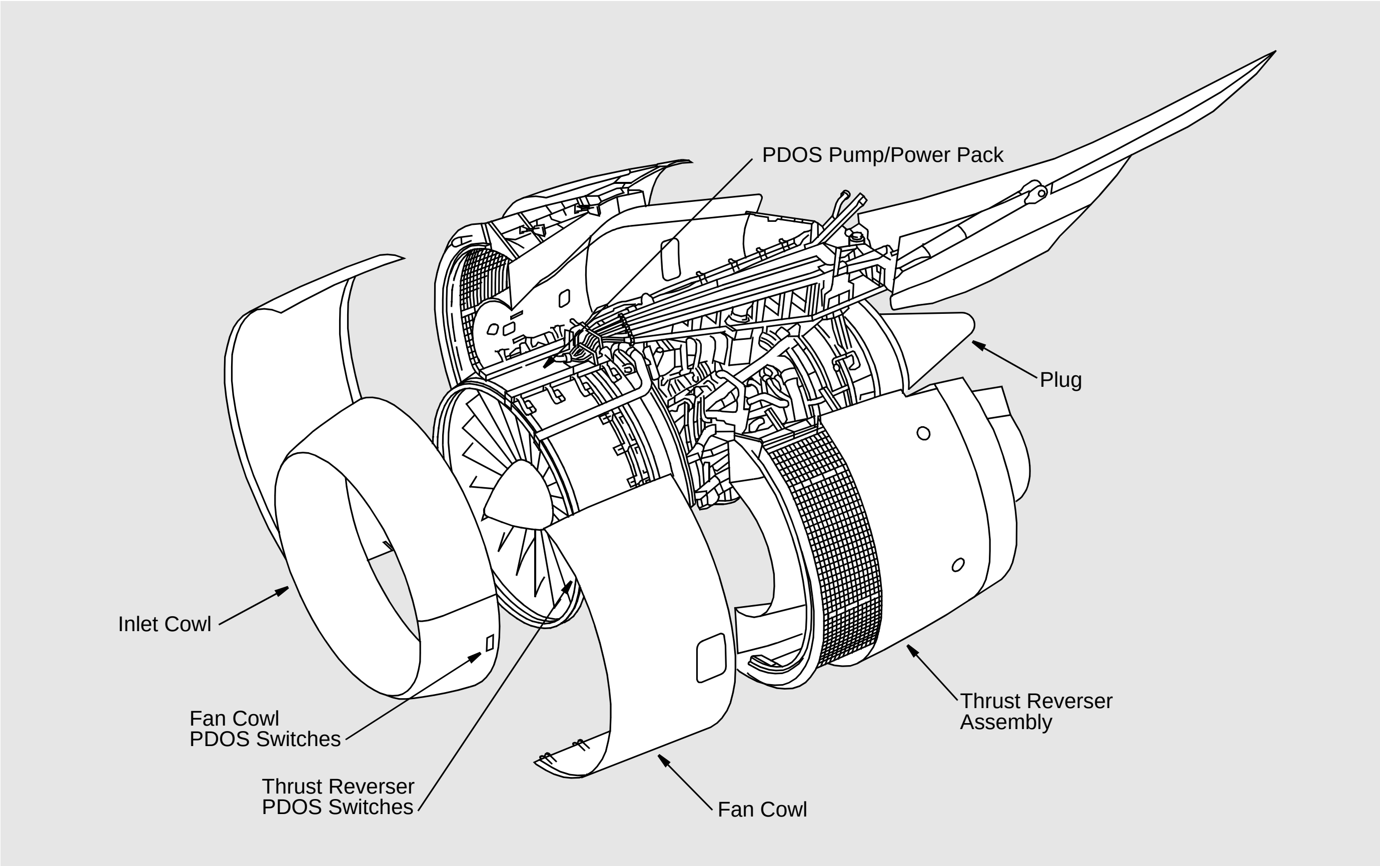
Most engine systems have design or parts commonality with the GE90-90 series engines.



Engine Left Side and Forward Gearbox Components



Engine Right Side and Aft Gearbox Components



Engine Cowling

Engine Cowling

Fixed and hinged cowls are the parts of the engine nacelle. The cowls permit smooth airflow through and around the engine. They also give protection to the engine components.

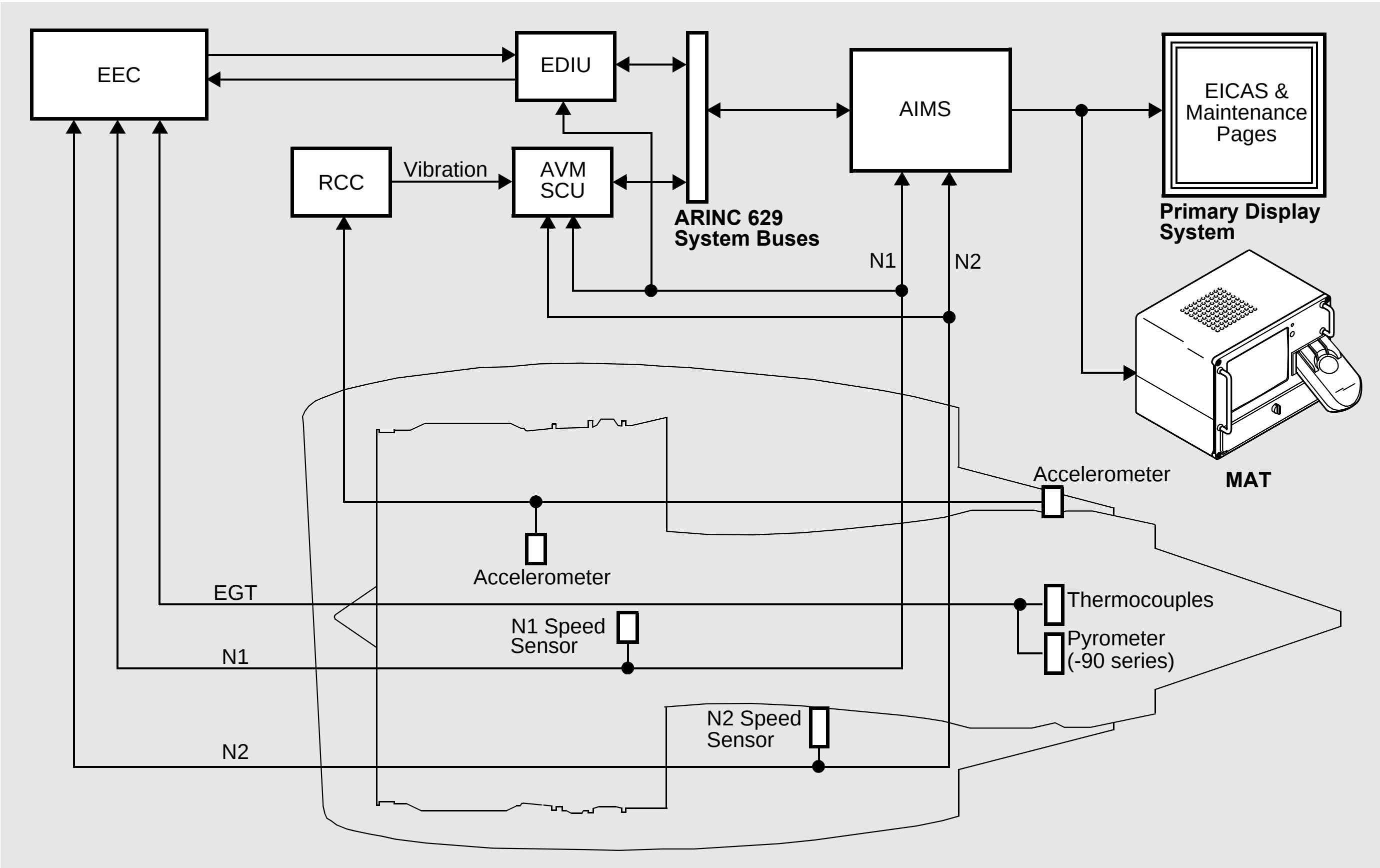
The fixed cowls include the inlet cowl and exhaust plug. The fixed cowls attach to engine flanges.

Hinged cowls include the fan cowl and thrust reverser assembly. They have hinges on the strut and latches on the bottom. There is no core cowl on this engine as was on earlier GE engines.

You open the hinged cowls to get access to engine components. The fan cowls and thrust reverser assemblies open hydraulically with the powered door opening system (PDOS). The PDOS includes these components:

- Fan cowl opening actuators (2)
- Thrust reverser assembly opening actuators (2)
- Strut-mounted pump/power pack
- Control switches (one set per side).

The PDOS is a self-contained system. If there is no electrical power, you can operate the PDOS manually to open the hinged cowls.



Engine Indication

Engine Indication System

The engine indication system supplies engine performance data to the AIMS and has these subsystems:

- Tachometer (N1 & N2)
- Exhaust gas temperature (EGT)
- Airborne vibration monitoring (AVM).

The EEC uses ARINC 429. An engine data interface unit (EDIU) changes ARINC 429 to ARINC 629.

The engine tachometer system supplies N1 and N2 signals to:

- EEC
- AIMS
- EDIU
- AVM signal conditioning unit (SCU).

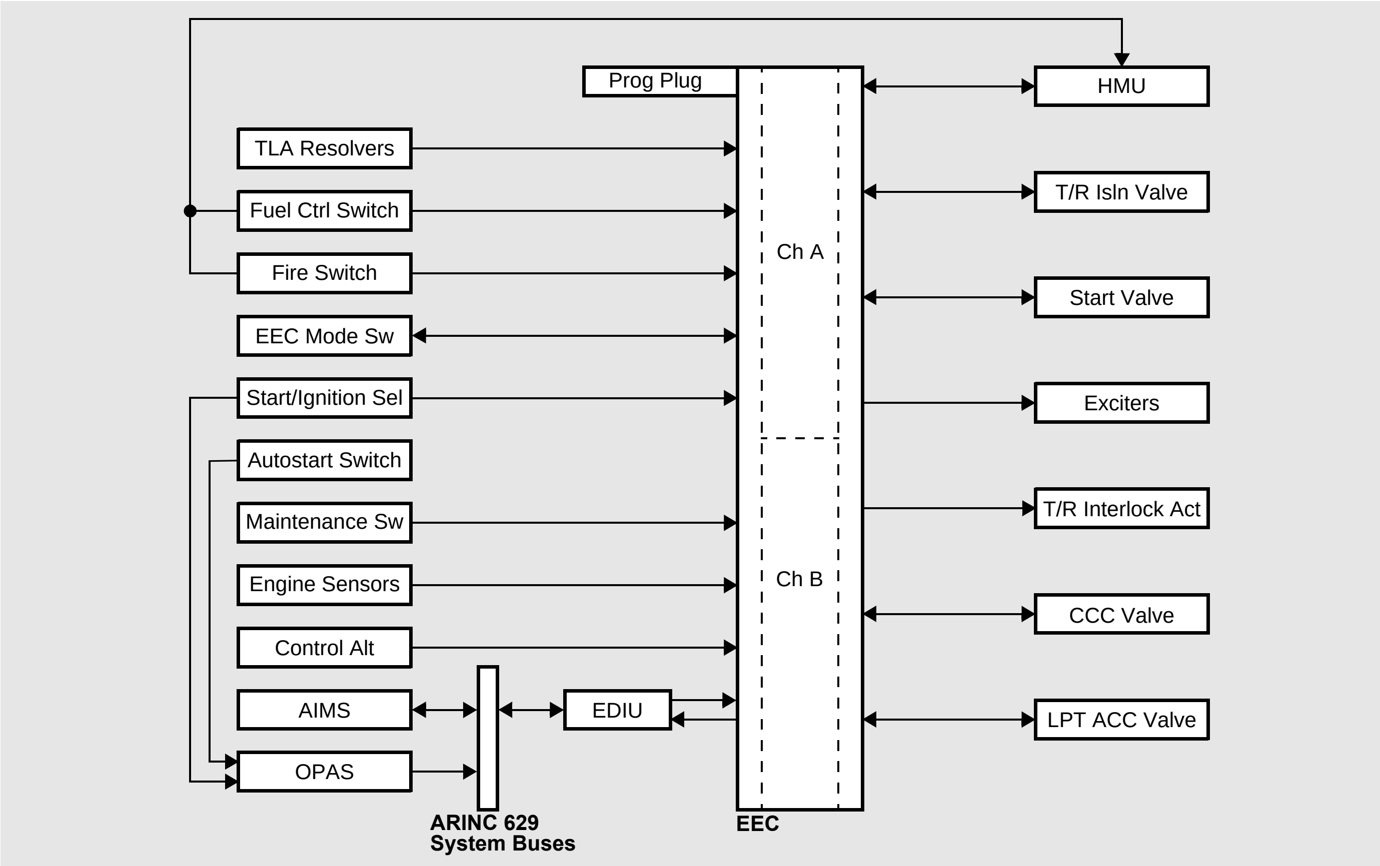
The N1 speed sensor on the fan hub frame measures fan shaft speed and is the main thrust indication. The N2 speed sensor is on the gearbox. The EICAS display shows N1 and the secondary engine display shows N2.

The EGT subsystem measures temperatures at the low pressure turbine (T49). The -90 series engines use two measurement techniques. At low temperatures, two thermocouple probes supply temperature signals to the EEC. During normal operation above 600C, a pyrometer (infrared sensor) measures the LPT first stage turbine blade temperature and supplies the signal to the EEC. The EEC uses the signals and sends them to the AIMS. EGT shows on the EICAS display. On the -100 series engines 8 thermocouple probes measure T49. The EEC does an average of the inputs for display.

The AVM system monitors engine vibration. Two accelerometers on each engine send vibration signals to the remote charge converter (RCC) in the strut. The RCC does an amplification of the signals and sends them to the AVM signal conditioning unit (SCU). The SCU uses the accelerometer signals and N1 and N2 speed signals to calculate vibration levels. The secondary engine display shows the vibration data. Engine vibration and phase angle data is also stored for use by the onboard engine balancing function of the SCU.

The maintenance pages show many engine parameters that go to the AIMS from the EEC.

The AIMS central maintenance function stores fault data that comes from the EEC. You use a maintenance access terminal (MAT) to see the fault data.



Engine Control System

Engine Control System

The full authority digital electronic control (FADEC) system controls these engine functions:

- Thrust management
- Engine systems control
- Engine fault detection, storage, and recall
- Engine communication with other airplane systems.

The heart of the system is the electronic engine control (EEC). The EEC is a two-channel digital electronic control. Each channel receives the necessary control inputs. Each channel also divides functionally so that if it is not able to do a specified control function. It uses that part of the other channel to do it.

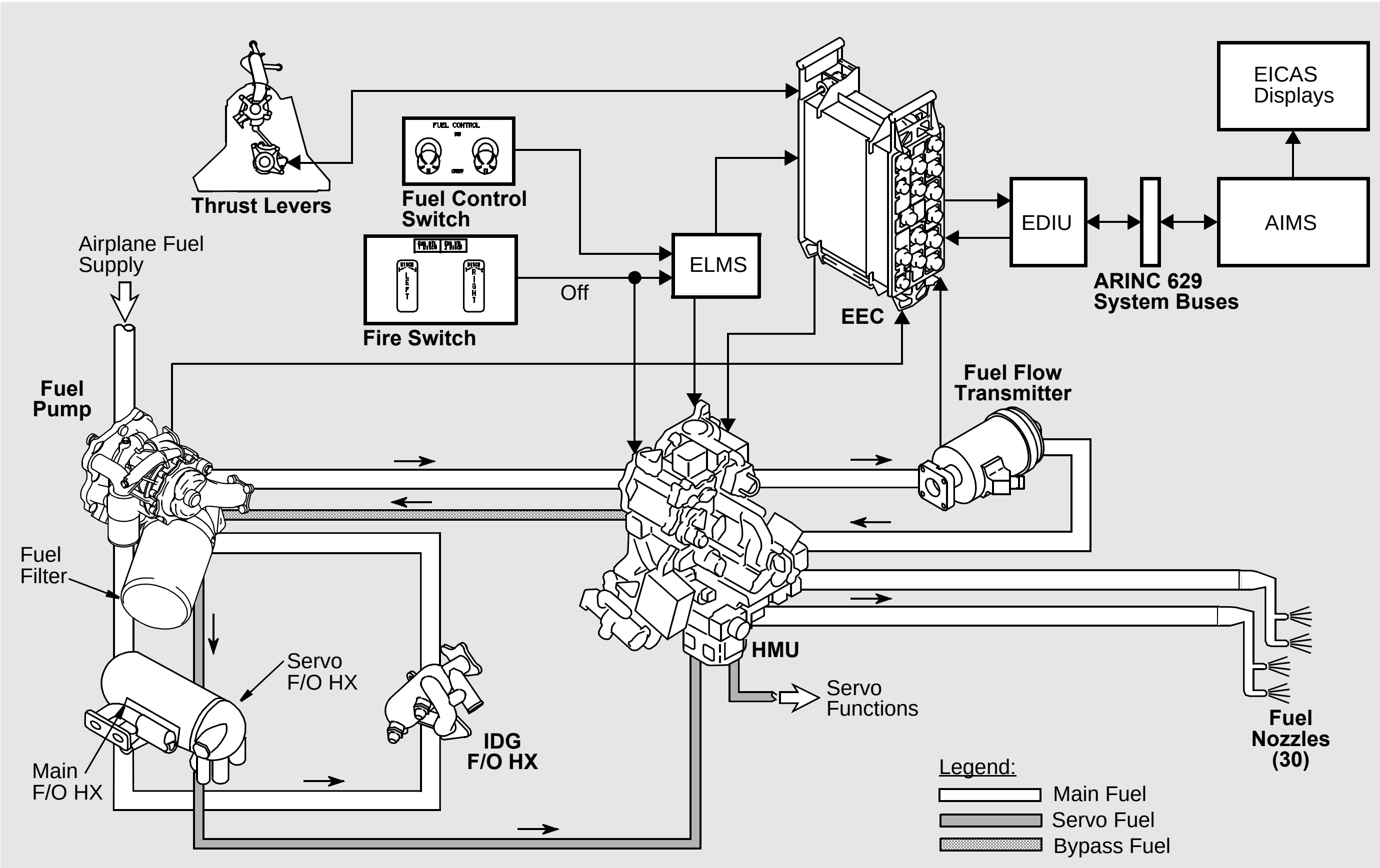
Most engine control inputs come from airplane sources. Engine sensors supply engine status data to the EEC.

The EEC controls these engine systems:

- Fuel
- Thrust reverser
- Starting
- Ignition
- Fuel and oil cooling
- Compressor airflow
- Nacelle ventilation
- Turbine cooling.

The EEC has two modes of operation, normal and alternate. If the normal mode does not operate, the EEC automatically changes to the alternate mode. You can also select the alternate mode with the EEC mode switches.

The engine-driven control alternator supplies power to the EEC. The flight deck maintenance switch connects airplane power to the EEC for maintenance.



Engine Fuel System

Engine Fuel System

The engine fuel system does these functions:

- Supplies fuel to the engine for combustion
- Removes heat from the engine and IDG oil
- Supplies servo fuel to the hydromechanical unit (HMU) and engine system actuators and valves.

The main gearbox turns a two-stage fuel pump. The fuel pump supplies high pressure fuel to the HMU. The fuel filter is part of the fuel pump housing.

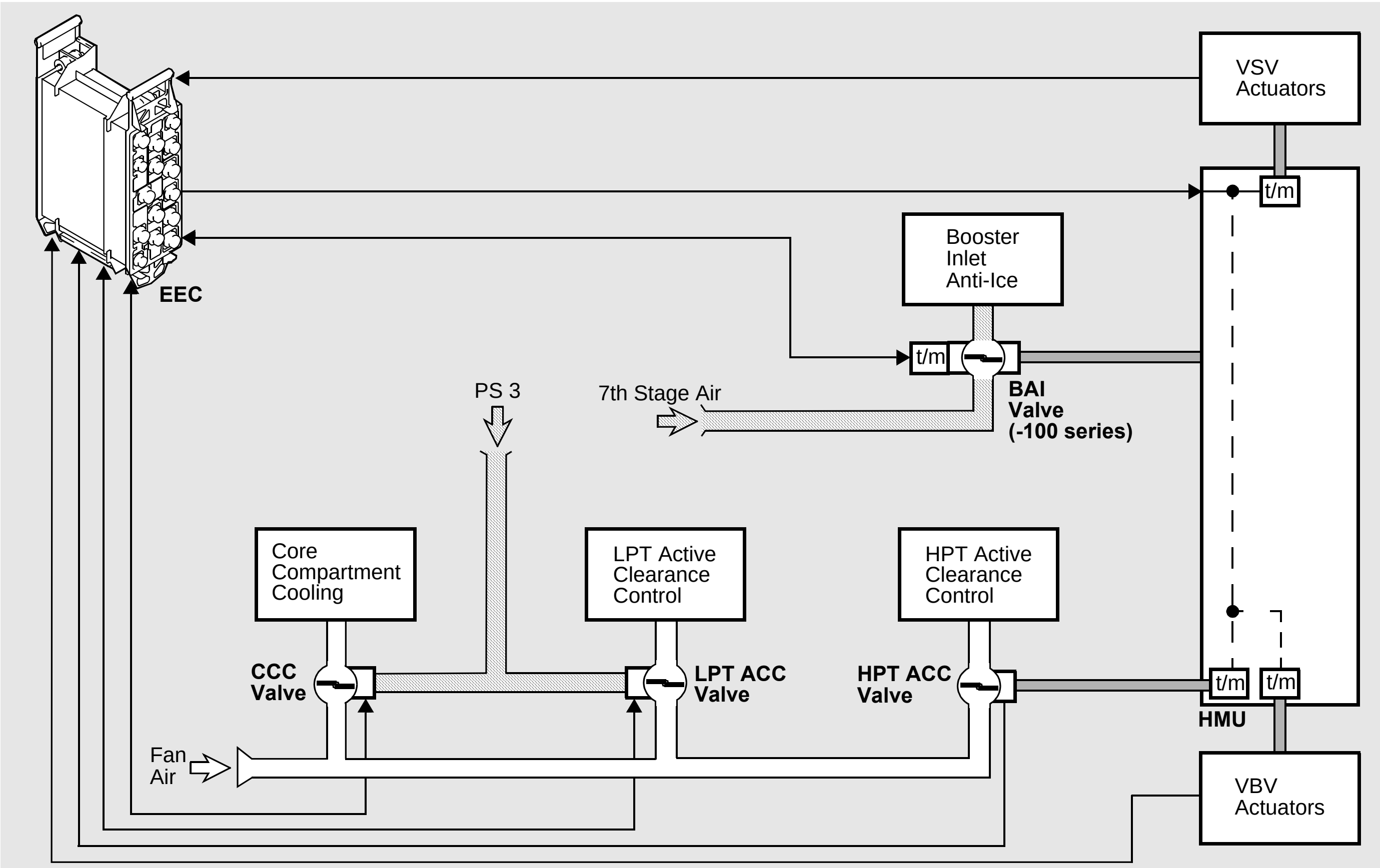
The main and servo fuel/oil heat exchangers are in a single unit. They add heat to the fuel to prevent icing.

The HMU supplies metered fuel to the engine for combustion in relation to thrust lever position and the engine operation condition. Fuel not used (bypass fuel) goes back to the fuel pump.

The EEC controls the HMU fuel metering valve. The fuel control switch and fire switch supply a direct command to the fuel shutoff valve in the HMU through the ELMS.

The fuel flow transmitter sends a signal to the EEC for indication on the engine primary format. The fuel filter differential pressure switch on the fuel pump housing also supplies an input to the EEC for indication.

Fuel flows from the fuel flow transmitter to two fuel manifolds. The fuel manifolds connect to 30 dual spray fuel nozzles.



Engine Air System

Engine Air System

The engine air system controls airflow through the compressors. It also supplies cooling air to engine systems and components. The EEC controls the air system components.

AIRFLOW CONTROL

Airflow control increases compressor stability during start, transient, and reverse thrust operations. The airflow control components include:

- Variable stator vanes (VSV)
- Variable bypass valves (VBV).

The stator vanes and bypass valves operate with servo fuel by torque motors in the HMU. The EEC controls the torque motors. Feedback comes from the actuators.

ENGINE COOLING

The engine air cooling system increases engine efficiency and extends engine life. Engine air removes heat from these parts of the engine:

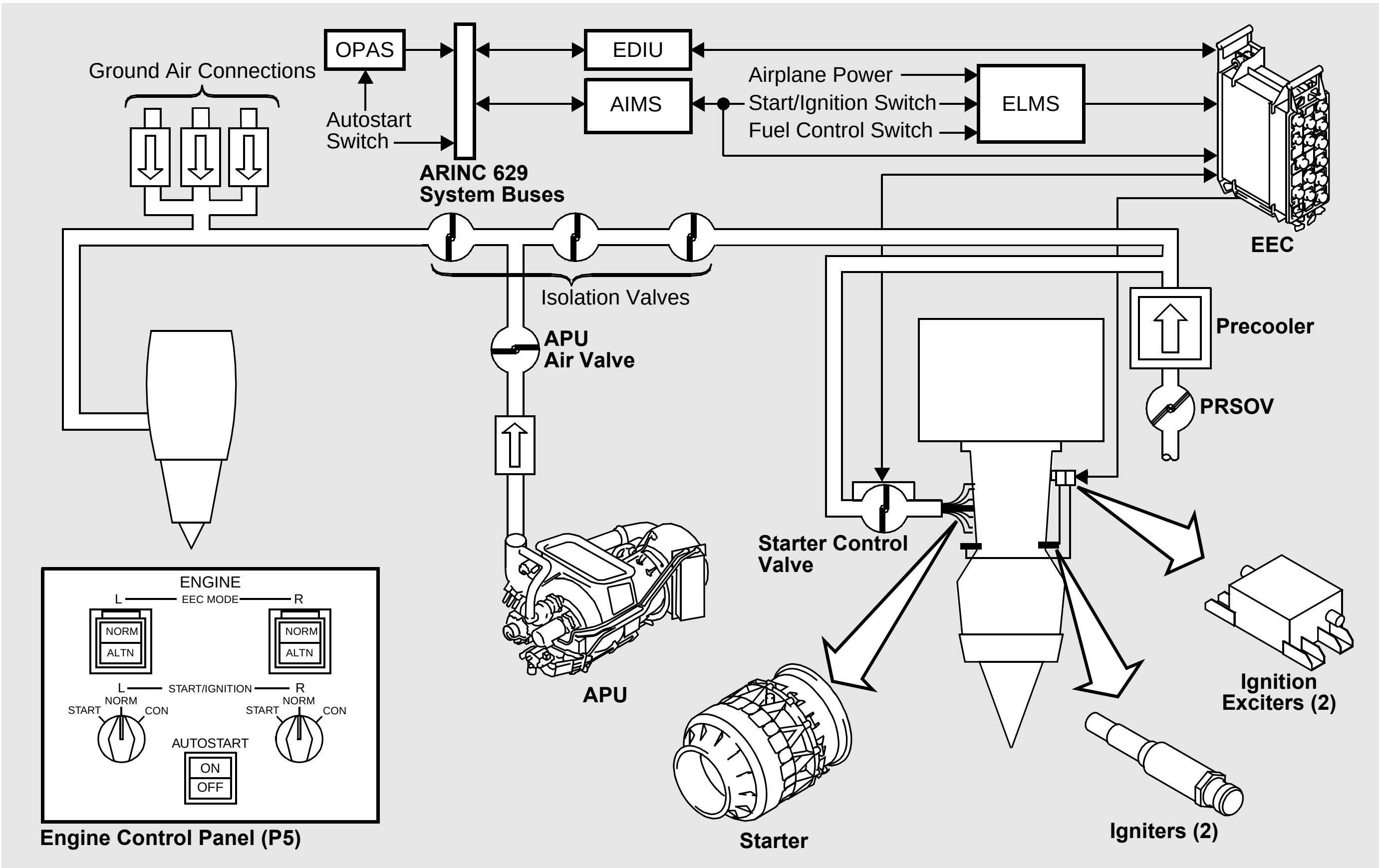
- Engine core compartment
- Turbine cases.

The core compartment cooling (CCC) system supplies fan air to remove heat from the engine core area. The CCC valve operates with HPC discharge pressure (PS 3).

The HPT and LPT active clearance control (ACC) systems supply fan air to remove heat from the HPT and LPT cases. The HPT ACC air valve operates with servo fuel pressure. The LPT ACC valve operates with PS 3.

BOOSTER INLET ANTI-ICE (-100 SERIES ENGINES)

The booster anti-ice (BAI) system gives warm seventh stage air to the booster inlet flow divider. The BAI valve operates with servo fuel pressure.



Engine Start and Ignition

Engine Start and Ignition Systems

START

The engine start system supplies the initial engine movement (N2) to permit fuel combustion. These are the components in the system:

- Starter control valve and solenoid
- Starter
- Flight deck controls.

Pneumatic sources for engine starts include:

- APU
- Ground air
- Engine crossbleed.

The isolation valves operate automatically to permit different pneumatic configurations.

The flight deck controls permit automatic or manual starts. During an autostart, the autostart switch is ON, and the fuel control switch is in the RUN position at the start of the start. The EEC controls fuel and ignition. The EEC also monitors the start sequence and makes corrections for fault conditions.

During a manual start, the autostart switch is OFF, and the fuel control switch is put to the RUN position at maximum motor. The EEC controls fuel and ignition, but the pilot must monitor the start sequence and make corrections for fault conditions.

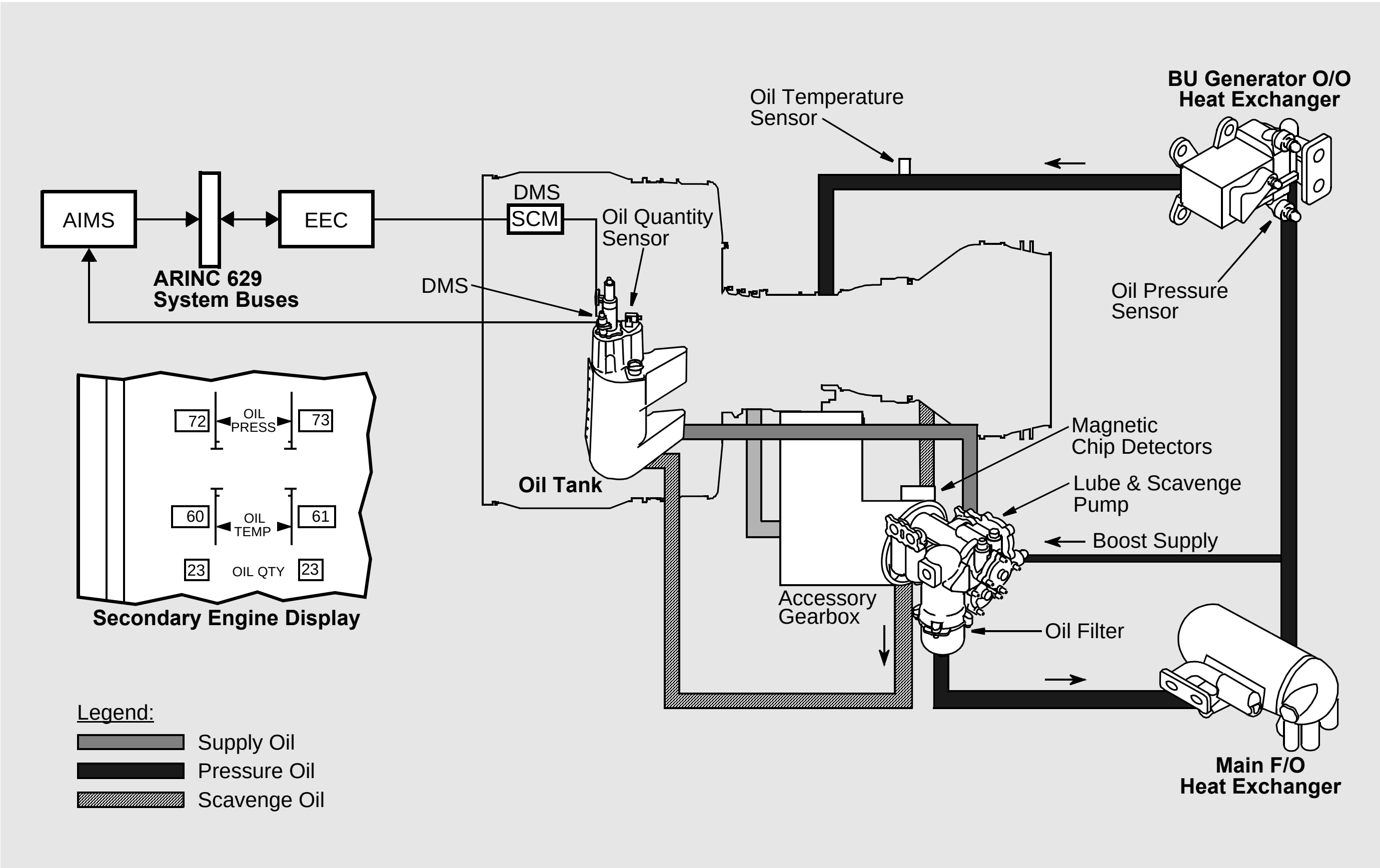
The EEC controls the starter operation with the starter control valve.

IGNITION

Each engine has two ignition systems that operate independently. They supply the spark to start or keep combustion in operation. These are the main components in the system:

- Ignition exciters
- Igniters
- Flight deck controls.

The flight deck controls permit continuous or automatic selection of ignition. The EEC controls ignition.



Engine Oil System

Engine Oil System

The engine oil system supplies oil to lubricate, remove heat, and clean engine bearings and gearboxes. The system also adds heat to engine fuel to prevent ice formation in the fuel.

The oil system has no regulation, so oil pressure changes with engine speed. The oil system has these sub-systems:

- Pressure
- Scavenge
- Indication.

PRESSURE

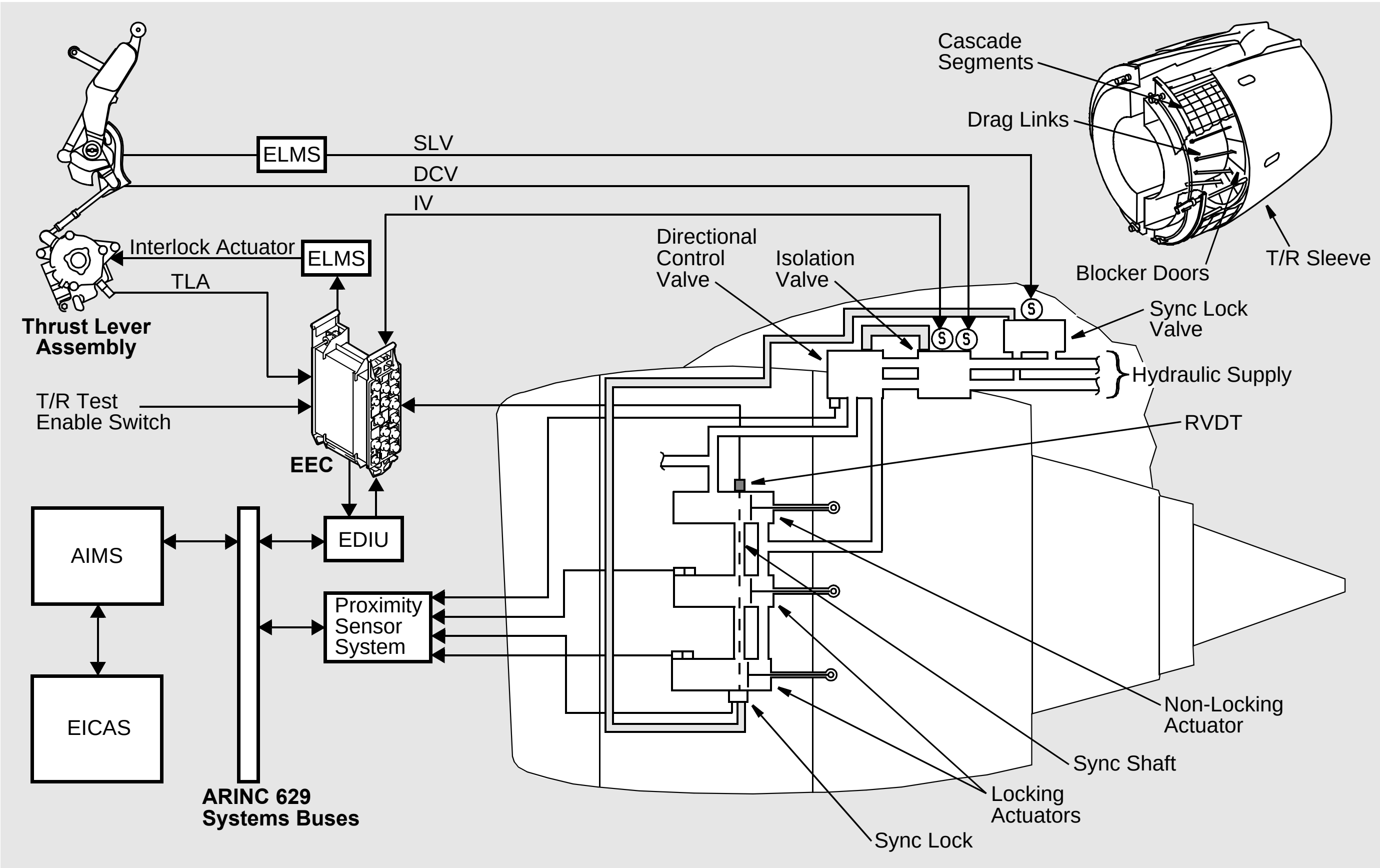
The pressure sub-system supplies oil to engine bearings and gearboxes. Oil flows from the oil tank to the pressure stage of the lube and scavenge pump. Pressurized oil then goes through a filter. The filter does a bypass of the oil if it has a blockage. Oil then flows through the main fuel/oil heat exchanger. The oil adds heat to the fuel as it decreases temperature. A small amount of boost supply oil goes back to the lube and scavenge pump before it goes to two of the engine main bearings. Oil flows through the backup generator oil/oil heat exchanger before it goes to the bearings and gearboxes.

SCAVENGE

The scavenge sub-system removes oil and contaminants from the bearing compartments and gearboxes. The lube and scavenge pump assembly has five scavenge pumps. Each pump removes oil from its bearing compartment or gearbox and sends it to the oil tank. A debris monitoring sensor (DMS) is on the oil tank. It collects metal particles in the return oil and counts their landing on the probe.

INDICATION

The indication sub-system supplies oil system data through the EEC to the AIMS. The secondary engine display shows oil pressure, temperature, and quantity. The EICAS display and status display show fault messages. Oil data also shows on the maintenance pages.



Engine Exhaust System

Engine Exhaust System

The engine exhaust system controls the direction of exhaust gases to supply forward and reverse thrust.

The thrust reverser (T/R) system supplies reverse thrust to decrease the speed of the airplane on the ground. Fan exhaust turns forward during reverse thrust.

The T/R system is electrically controlled and hydraulically operated. You can operate it manually for maintenance.

COMPONENTS

There are two T/R halves on each engine. Each half includes:

- T/R sleeve
- Blocker doors
- Drag links
- Cascade segments
- Hydraulic actuators
- Synchronizing (sync) shaft and lock
- Proximity sensors.

These other T/R components are in the strut:

- Isolation valve (IV)
- Directional control valve (DCV)
- Sync lock valve (SLV).

System components include reverse thrust levers in the flight deck and interlock actuators below the control stand.

OPERATION

When you lift the reverse thrust lever, these three things occur to extend the translating cowl:

- SLV releases the sync lock
- DCV moves to the deploy position
- EEC energizes the IV.

The EEC controls the operation of the T/R. The IV supplies hydraulic pressure to the T/R system. The hydraulic actuators extend the T/R. When the reverser extends, the EEC energizes the interlock actuators. This permits more movement of the reverse thrust levers to increase reverse power.

When you put the reverse thrust lever to the down position, the T/R retracts. The locking actuators and sync shaft lock to keep the reverser in the stowed position.

RVDTs and proximity sensors monitor the T/R system for fault conditions. The RVDTs also supply signals for T/R control and flight deck indications.

A maintenance switch on the fan case permits a bypass of the EEC engine run logic to let the T/R deploy during maintenance.

EPCS PG 1/2

LEFT ENGINE				RIGHT ENGINE		
$\boxed{A}$	B	TACH		$\boxed{A}$	B	TACH
97.2	97.2	97.2	N_1	97.2	97.2	97.2
103.7	103.7	103.7	N_2	103.7	103.7	103.7
72.0	72.0		TRA	72.0	72.0	
0.0	0.0		T/R_L	0.0	0.0	
0.0	0.0		T/R_R	0.0	0.0	
4.7	4.7		P_{AMB}	4.7	4.7	
276	276		P_{S3}	276	276	
-17	-17		T_{12}	-17	-17	
39	39		T_{25}	39	39	
528	528		T_3	528	528	
0	0		VBV	0	0	
81	81		VSV	81	81	
0	0		STB	0	0	

DATE02 SEP 94 UTC18:54:04

EPCS PG 2/2

LEFT ENGINE			RIGHT ENGINE	
$\boxed{A}$	B		$\boxed{A}$	B
52	52	FMV	52	52
0	0	BSV	0	0
100	100	MSV	100	100
30	30	HPT ACC	30	30
OPEN	OPEN	LPT ACC	OPEN	OPEN
CLOSED	CLOSED	CCC	CLOSED	CLOSED
60	60	OIL T	61	61
73	73	OIL P	72	72
4	4	OIL FLT	4	4
3	3	FUEL FLT	3	3
0000	0000	STATUS 1	0000	0000
0000	0000	STATUS 2	0000	0000
0000	0000	STATUS 3	0000	0000
0000	0000	STATUS 4	0000	0000

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Maintenance Pages

Features

ENGINE

The Rolls-Royce Trent 800 engine is a growth version of the RB211 engines. It has advanced wide-chord fan blades.

POWERED DOOR OPENING SYSTEM (PDOS)

The two thrust reverser assemblies and fan cowls have a powered door opening system.

INDICATION

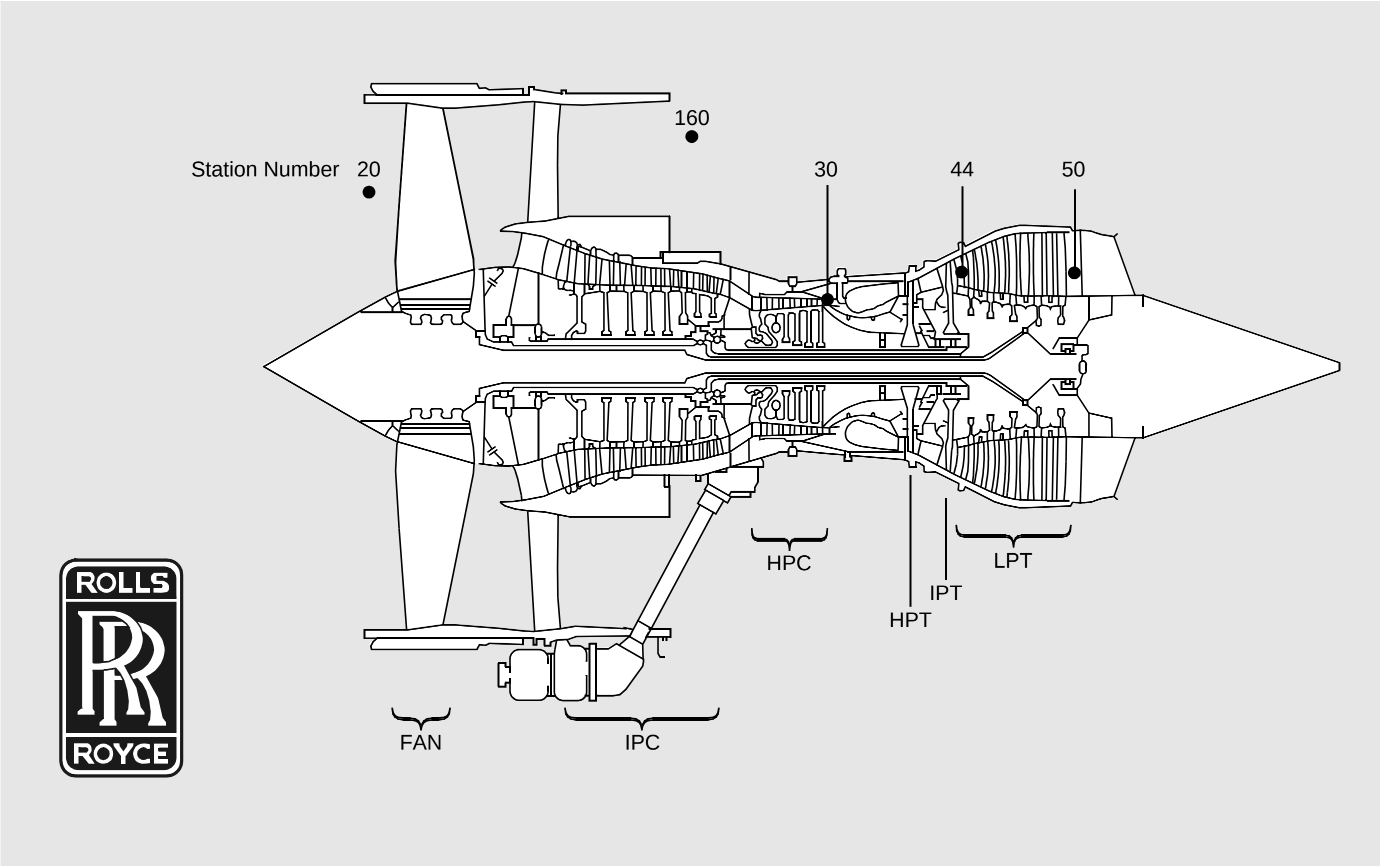
Most engine parameters go to the AIMS from the electronic engine controller (EEC). EICAS pages show engine parameters and dispatch data. Four primary display system maintenance pages show engine maintenance data.

CONTROL

The Trent engine uses a dual channel, full authority digital electronic control (FADEC) system. The main component of the FADEC system is the electronic engine controller (EEC). The EEC controls:

- Engine systems
- Starts and autostarts
- Thrust reverser operation.

The EEC also supplies fault monitoring data to the central maintenance computing system (CMCS).



Engine Specifications

RB211 Trent 800

The Rolls-Royce RB211 Trent 800 engine is a high bypass ratio, three-spool turbofan engine. The low pressure shaft (N1) has these components:

- 110 inch (2.8 m) fan
- Five-stage low pressure turbine (LPT).

The intermediate pressure shaft (N2) has these components:

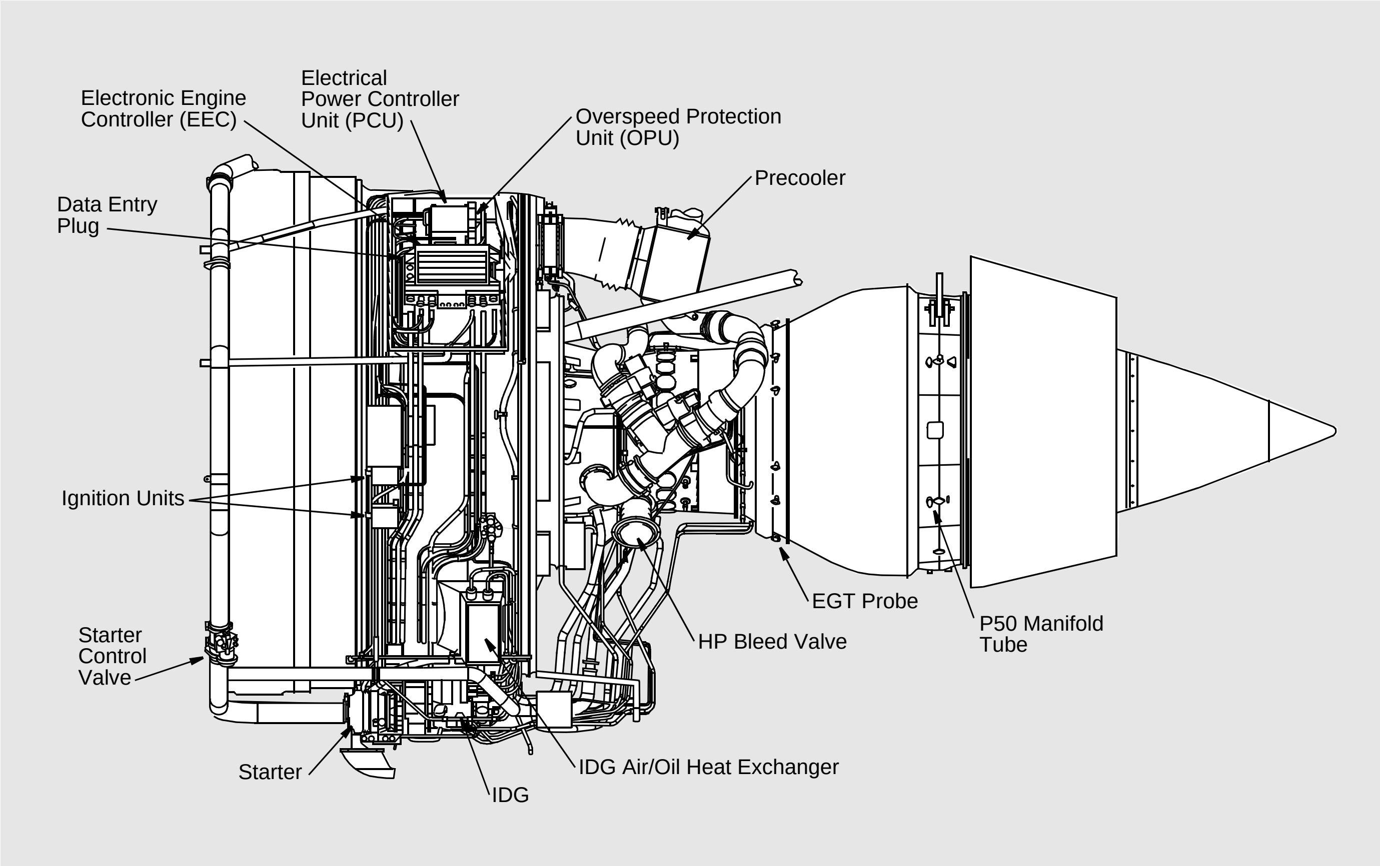
- Eight-stage intermediate pressure compressor (IPC)
- Single stage intermediate pressure turbine (IPT).

The high pressure shaft (N3) turns the external gearbox and has these components:

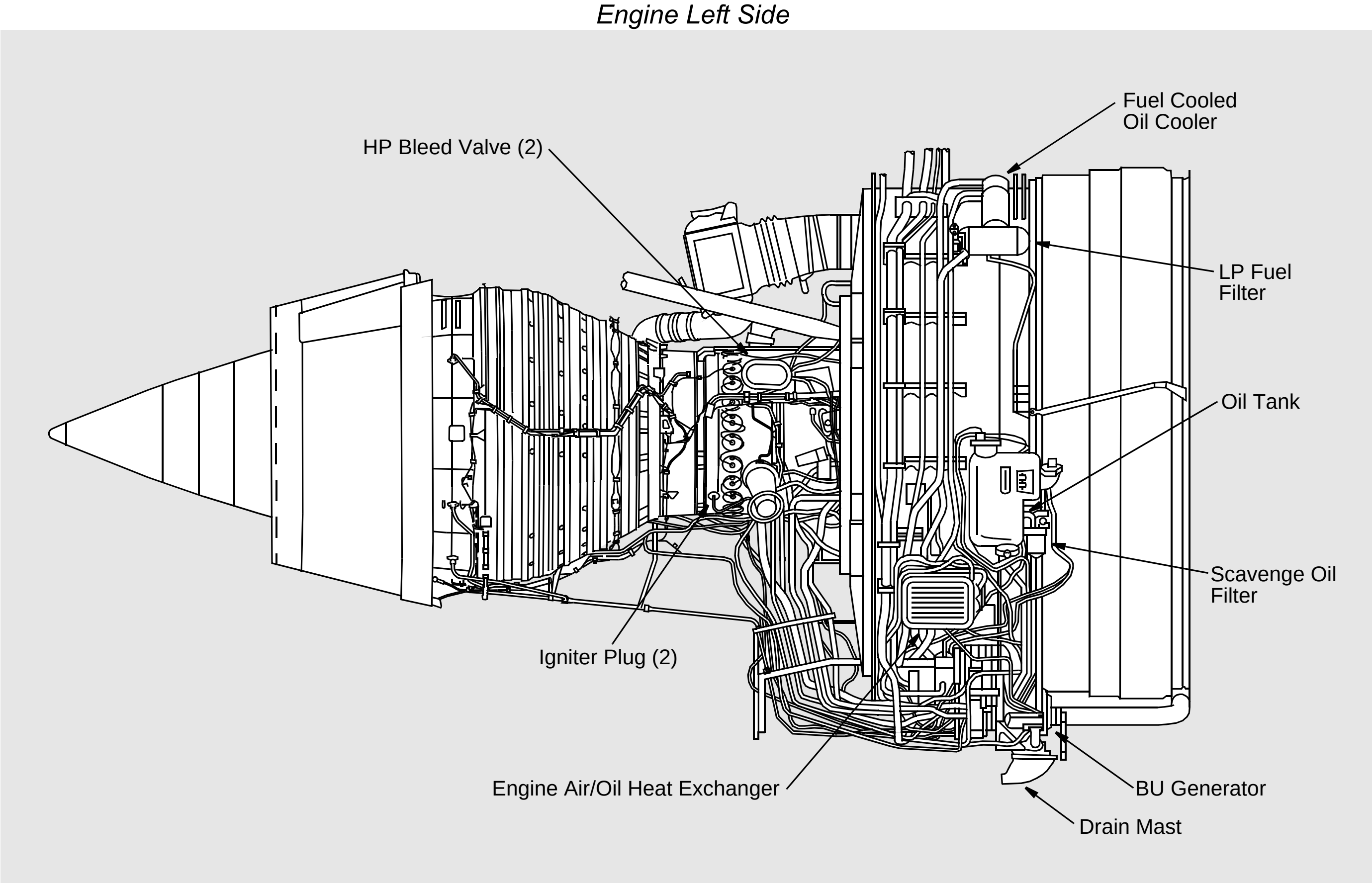
- Six-stage high pressure compressor (HPC)
- Single stage high pressure turbine (HPT).

The Trent 800 engines have different takeoff thrust ratings. An external data entry plug selects different software in the EEC to set the ratings.

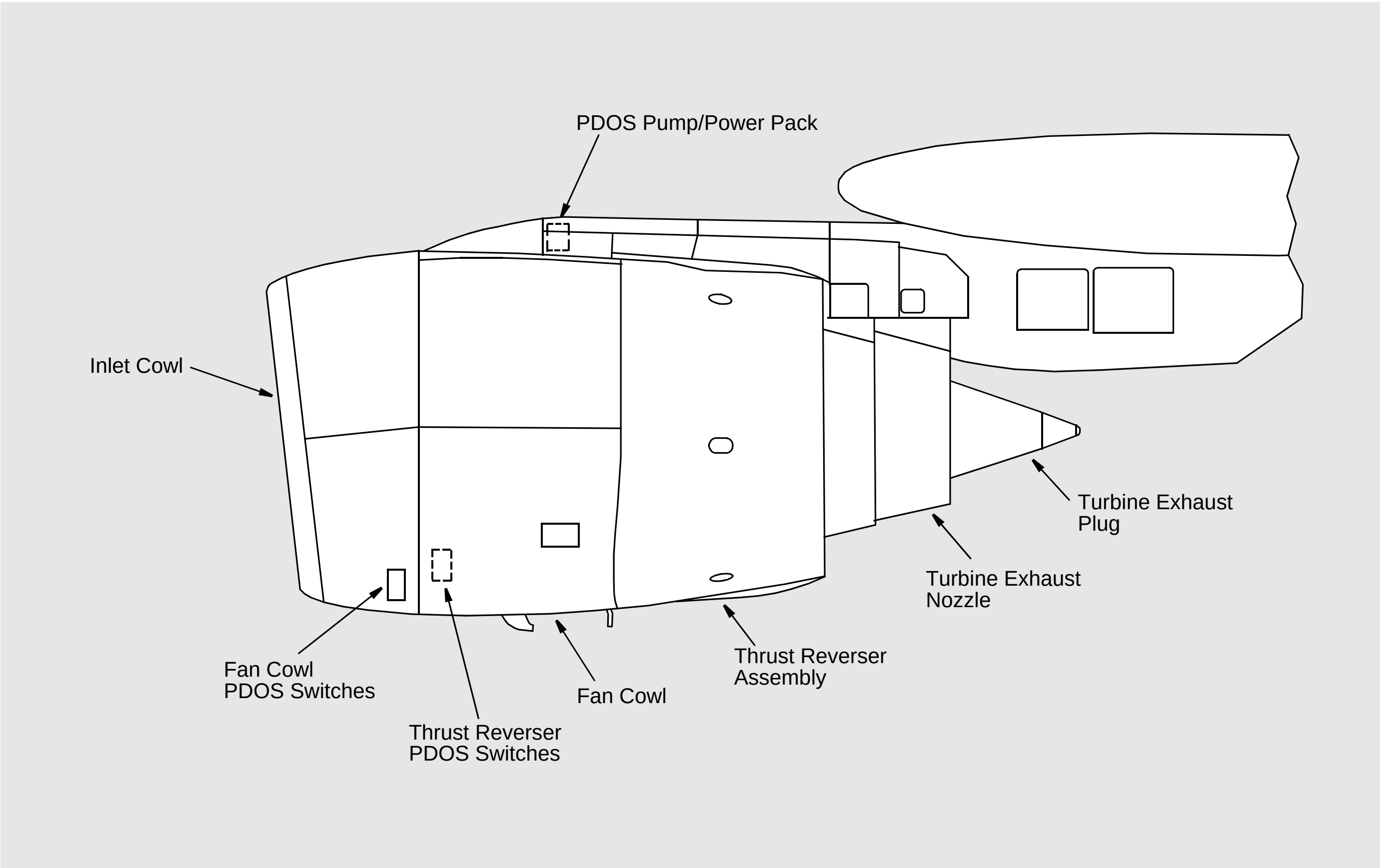
Most of the engine line replaceable units (LRUs) are on the fan case of the engine or the gearbox. You open the fan cowl to get access to these components. Some LRUs are on the core of the engine and you open the thrust reverser assembly to get to them.



Engine Left Side



Engine Right Side



Engine Cowling

Engine Cowling

Fixed and hinged cowls make up the engine nacelle. The cowls permit smooth airflow through and around the engine. They also protect the components installed on the engine.

These are the fixed cowls:

- Inlet cowl
- Turbine exhaust nozzle
- Turbine exhaust plug.

The fixed cowls attach to engine flanges.

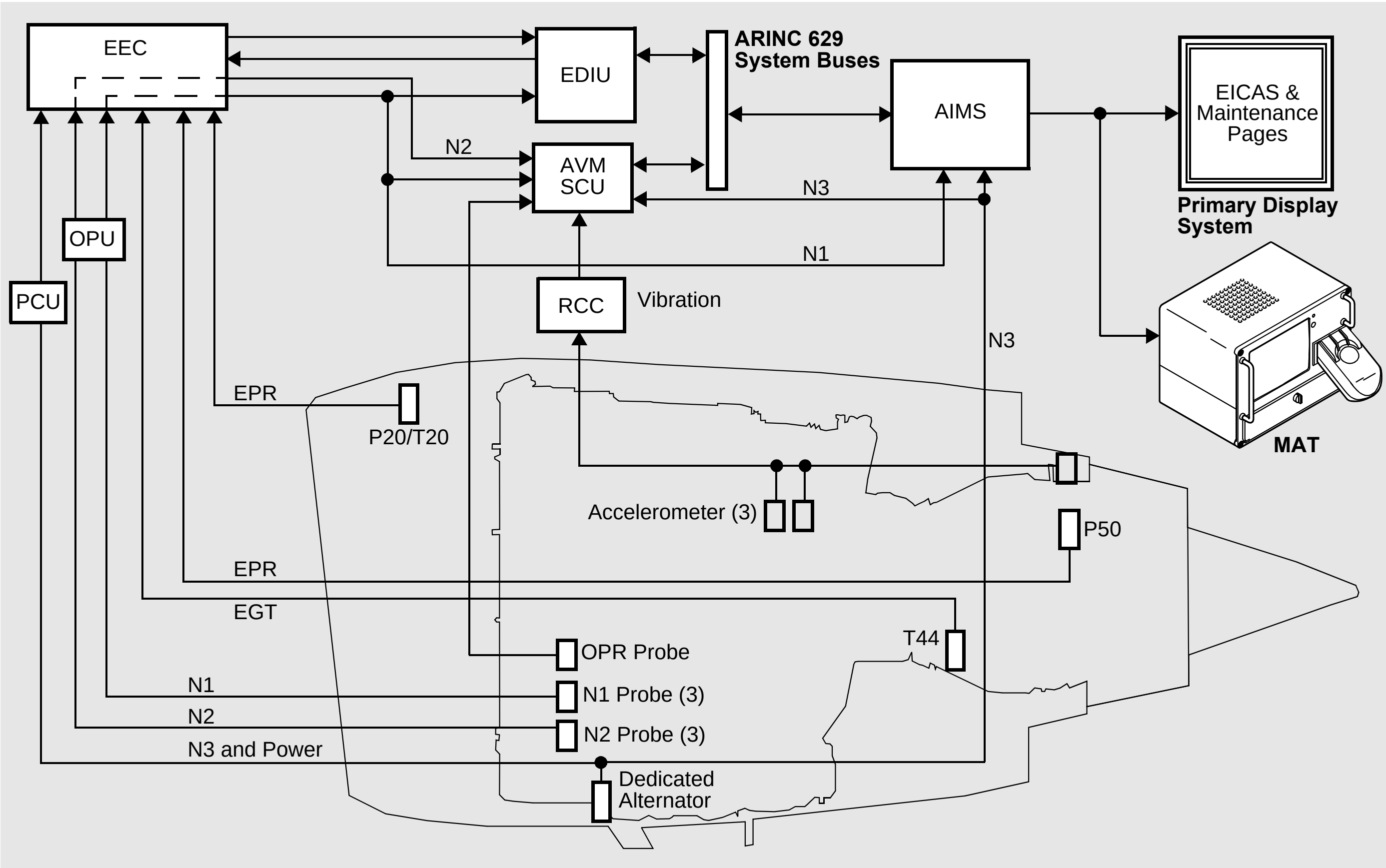
Hinged cowls include the fan cowl and thrust reverser assembly. They hinge to the fan cowl support beam and the strut. The cowl latches are on the bottom. There is no core cowl on the engine.

You open hinged cowls to get access to engine components. The fan cowls and thrust reverser assemblies open hydraulically with the powered door opening system (PDOS).

The PDOS has these components:

- Fan cowl actuators (2)
- Thrust reverser assembly actuators (2)
- Strut-mounted pump/power pack
- Control switches (one set per side).

The PDOS is a self-contained system. You can override it and open the hinged cowls mechanically.



Engine Indication

Engine Indication System

The engine indication system supplies engine performance data to the AIMS. The system has these subsystems:

- Engine pressure ratio (EPR)
- Shaft speed (N1, N2, and N3)
- Exhaust gas temperature (EGT)
- Airborne vibration monitoring (AVM).

The EEC uses ARINC 429. To communicate with the airplane ARINC 629, an engine data interface unit (EDIU) changes ARINC 429 to ARINC 629.

EPR

EPR is the main thrust indication. It is the ratio of low pressure turbine exhaust pressure (P50) over fan inlet pressure (P20). The EEC calculates EPR. EPR shows on the EICAS display.

SHAFT SPEED

The engine shaft speed system supplies N1, N2, and N3 speed signals to the EEC, AIMS, the EDIU, and the AVM signal conditioning unit (SCU). Speed probes supply the N1 and N2 signals through the overspeed protection unit (OPU). The dedicated alternator gives the N3 signal through the electrical power controller unit (PCU). The EICAS display shows N1 and the secondary engine display shows N2 and N3.

EGT

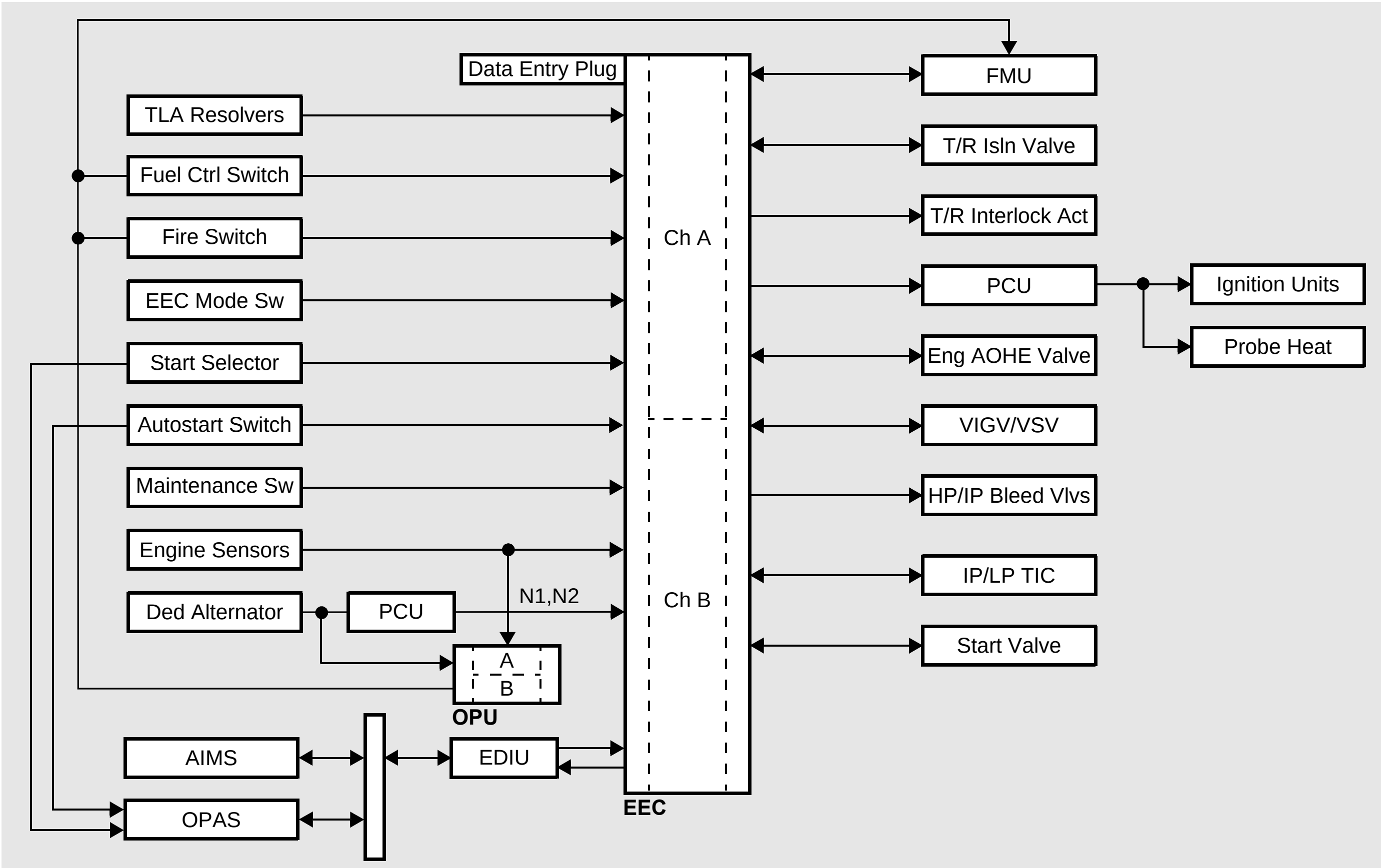
The EGT subsystem measures intermediate pressure turbine exhaust temperature (T44). Eleven temperature probes supply a signal to the EEC. The EEC processes the signal and sends it to the AIMS. The EICAS display shows the EGT.

AVM

The AVM system monitors engine vibration. Three accelerometers on each engine supply vibration signals to the remote charge converter (RCC) in the strut. The RCC amplifies the signals and sends them to the AVM SCU. The SCU uses the signals and rotor speed signals to calculate vibration levels.The secondary engine display shows the vibration.
A once-per-rev (OPR) speed probe supplies a signal for fan balancing.

MAINTENANCE

The maintenance pages show many engine parameters. You use a CDU to see the maintenance pages. The CMCS stores fault data that comes from the EEC. You use a maintenance access terminal (MAT) to get the fault data.



Engine Control System

Engine Control System

The full authority digital electronic control (FADEC) system controls these engine functions:

- Thrust management
- Engine systems control
- Engine fault detection, storage, and recall
- Engine communication with other airplane systems.

The heart of the system is the electronic engine controller (EEC). The EEC is a two-channel digital electronic control. Each channel receives the necessary control inputs and can control the engine.

Most engine control inputs come from airplane sources. Engine sensors supply engine status data to the EEC.

The EEC controls these engine systems:

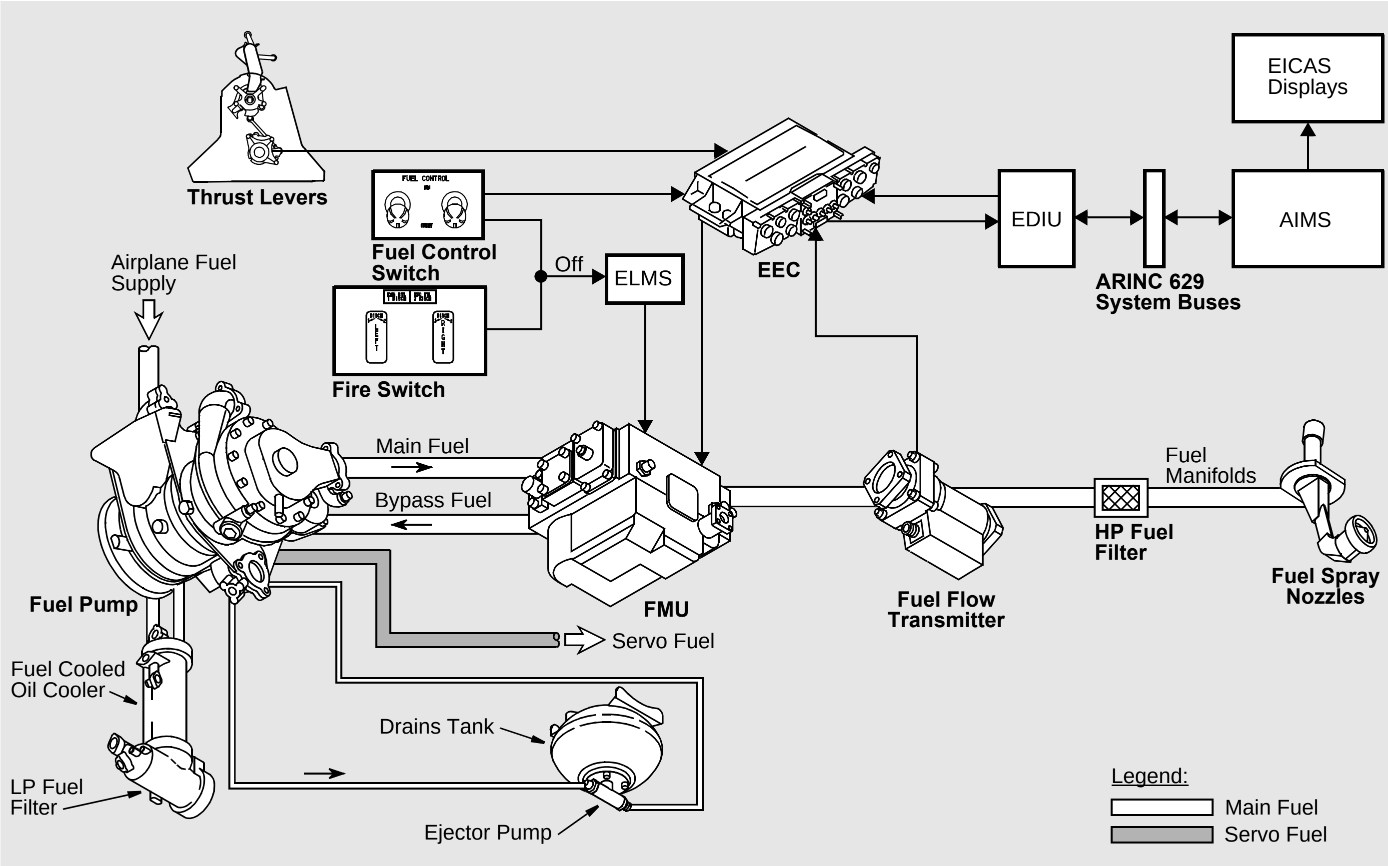
- Fuel
- Thrust reverser
- Starting
- Ignition
- Probe heat
- Oil cooling
- Compressor airflow
- Turbine impingement cooling.

The EEC has two modes of operation, normal and alternate. If the normal mode does not operate, the EEC automatically changes to the alternate mode. You can also select the alternate mode with the EEC mode switches.

The engine-driven dedicated alternator supplies power to the power controller unit (PCU) and the overspeed protection unit (OPU). The PCU supplies power to the EEC, ignition units, and probe heat.

The OPU receives N1 and N2 signals to independently give overspeed protection to the engine.

The flight deck maintenance switch connects airplane power to the EEC for maintenance.



Engine Fuel System

Engine Fuel System

The engine fuel system supplies fuel to the engine for combustion and cools the engine oil. It also supplies servo fuel to engine system control actuators.

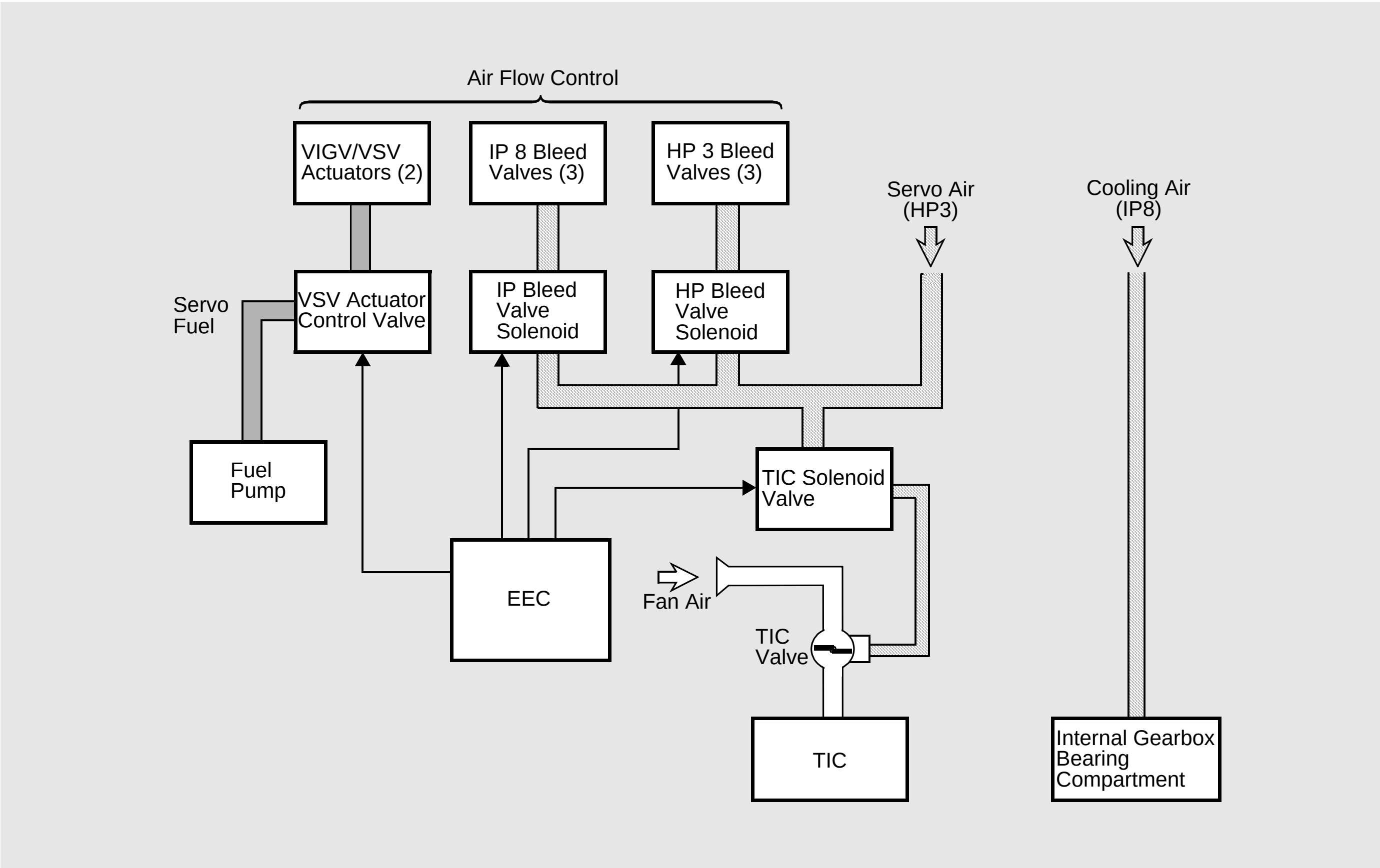
The airplane fuel system supplies fuel to the engine fuel pump. The external gearbox turns the two-stage fuel pump. Low pressure fuel flows from the fuel pump, through the fuel cooled oil cooler and LP fuel filter, and back to the fuel pump.The pump then supplies high pressure fuel to the fuel metering unit (FMU) and servo fuel to the engine system control actuators.

The FMU supplies metered fuel to the engine for combustion based upon thrust lever position and the engine’s operating condition. Fuel not used for combustion (bypass fuel) goes back to the fuel pump.

The EEC controls the FMU and supplies fuel on/off commands. The fuel control switch and fire switch can supply a direct fuel off command to the FMU through the ELMS.

Metered fuel flows from the FMU to the fuel flow transmitter. The fuel flow transmitter sends a signal to the EEC for flight deck indication.

Fuel flows from the fuel flow transmitter through the high pressure fuel filter to the fuel spray nozzles.



Engine Air System

Engine Air System

The engine air system controls air flow through the compressors. It also supplies cooling air to engine systems and components. The EEC controls the air system components.

AIR FLOW CONTROL

Air flow control increases compressor stability during start, transient, and reverse thrust operations. The EEC controls these air flow control components:

- Variable stator vanes (VSV)
- Variable inlet guide vanes (VIGV)
- IP 8 bleed valves
- HP 3 bleed valves.

The VSVs mechanically lock to the VIGVs under normal conditions. When the VSV actuator control valve moves the VSVs with the VSV actuators, it also moves the VIGVs.

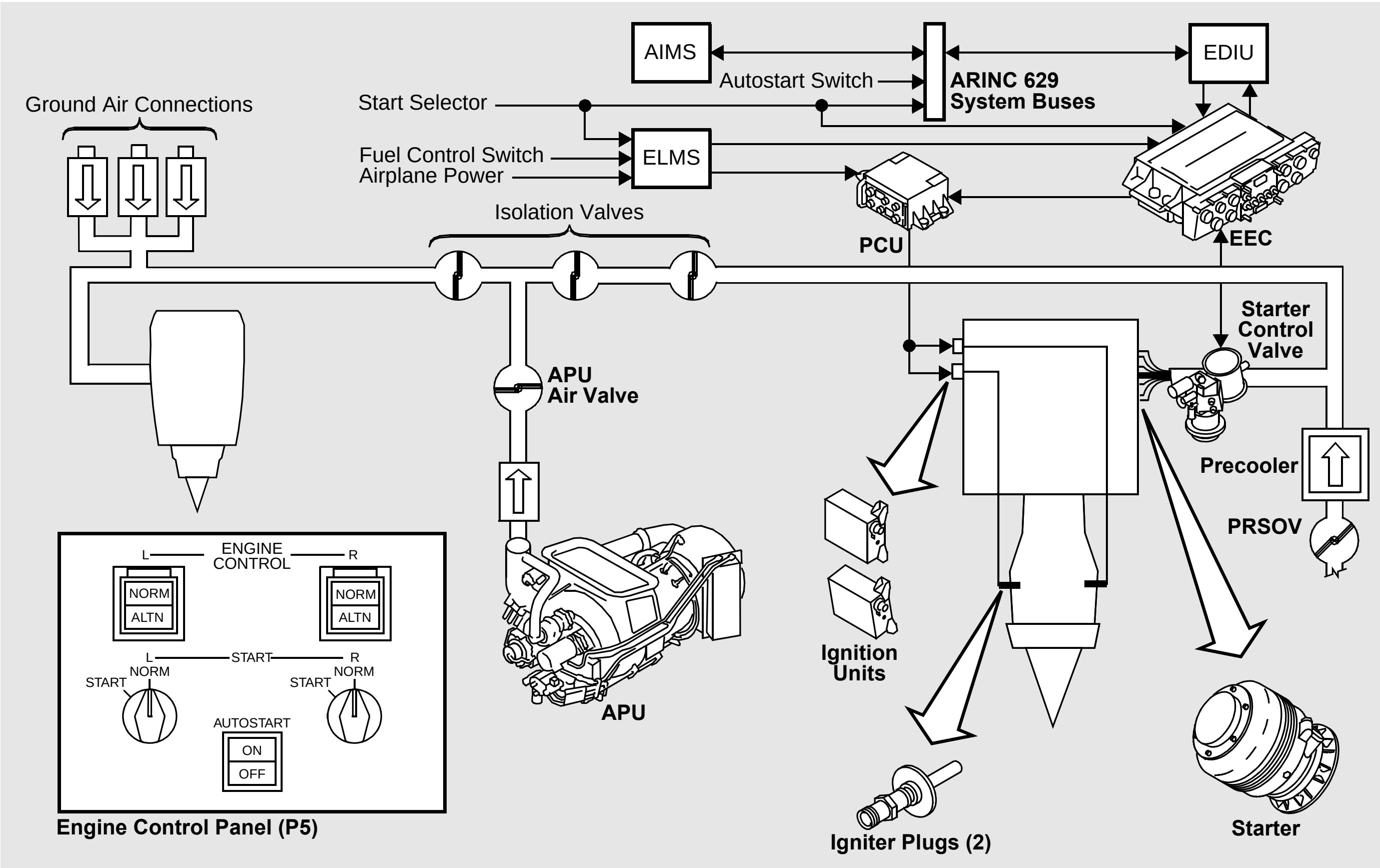
The EEC controls the pneumatically-operated bleed valves with solenoids to ensure engine operating stability.

ENGINE COOLING

The engine air cooling system increases engine efficiency and extends engine life. Engine air cools the turbine cases and the internal gearbox bearing compartment.

The turbine impingement cooling (TIC) valve supplies fan air to cool the IPT and LPT cases. The TIC solenoid valve pneumatically opens the TIC valve. The EEC controls the TIC valve.

IP compressor air (IP8) cools the internal gearbox bearing compartment.



Engine Start and Ignition

Engine Start and Ignition Systems

START

The engine start system supplies the initial engine movement (N3) to permit fuel combustion. The system has these components:

- Starter control valve
- Starter
- Flight deck controls.

Pneumatic sources for engine starts include these:

- APU
- Ground air
- Engine crossbleed.

The isolation valves operate automatically to permit different pneumatic configurations.

The flight deck controls permit automatic or manual starts. During an autostart, the autostart switch is ON, and the fuel control switch is in the RUN position at the start of the start. The EEC controls fuel and ignition. The EEC also monitors the start sequence and makes corrections for fault conditions.

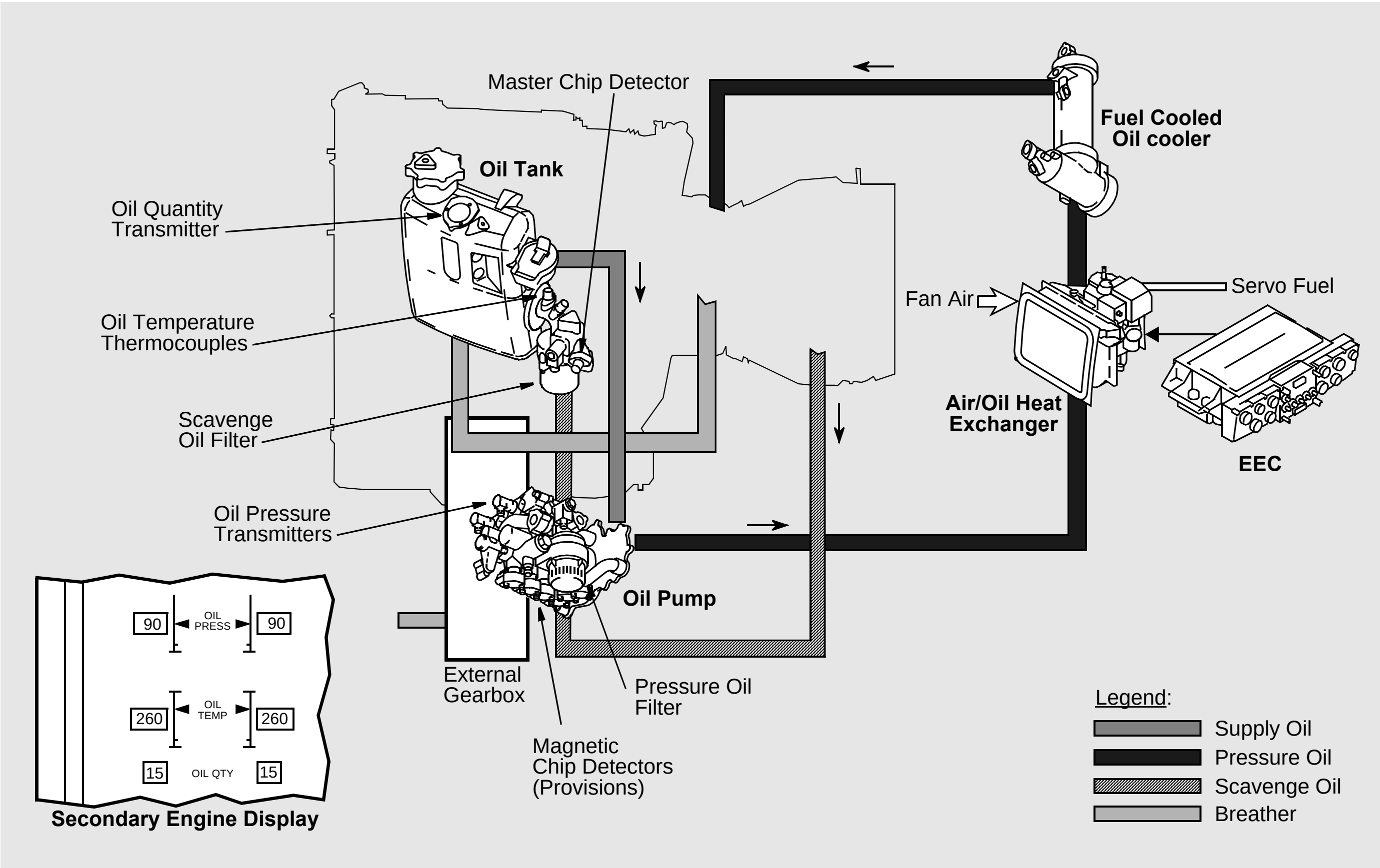
During a manual start, the autostart switch is OFF, and the fuel control switch is put to the RUN position at maximum motor. The EEC controls fuel and ignition, but the pilot must monitor the start sequence and make corrections for fault conditions.

The EEC controls the starter operation with the starter control valve.

IGNITION

Each engine has two ignition systems that operate independently. They supply the spark to start or keep combustion in operation. The main components in the system are the ignition units and igniter plugs.

The EEC completely controls ignition. There is no continuous ignition selection in the flight deck. Relays in the power controller unit (PCU) connect power to one or the two exciters.



Engine Oil System

Engine Oil System

The engine oil system supplies oil to lubricate, cool, and clean engine bearings and gearboxes. The system also heats engine fuel to prevent ice formation in the fuel. The oil system is unregulated so that oil pressure changes with engine speed. The oil system has these subsystems:

- Pressure
- Scavenge
- Breather
- Indication.

PRESSURE

The pressure subsystem supplies oil to the engine bearings and gearboxes. Oil flows from the oil tank to the pressure stage of the oil pump. Pressurized oil then goes through a filter. Next, oil flows through the engine air/oil heat exchanger and the fuel cooled oil cooler.

The fuel cooled oil cooler is the primary source of cooling for engine oil. When additional cooling is necessary, the EEC sends a signal to open the air/oil heat exchanger valve. This lets fan air cool the oil. The valve is a modulating valve.

SCAVENGE

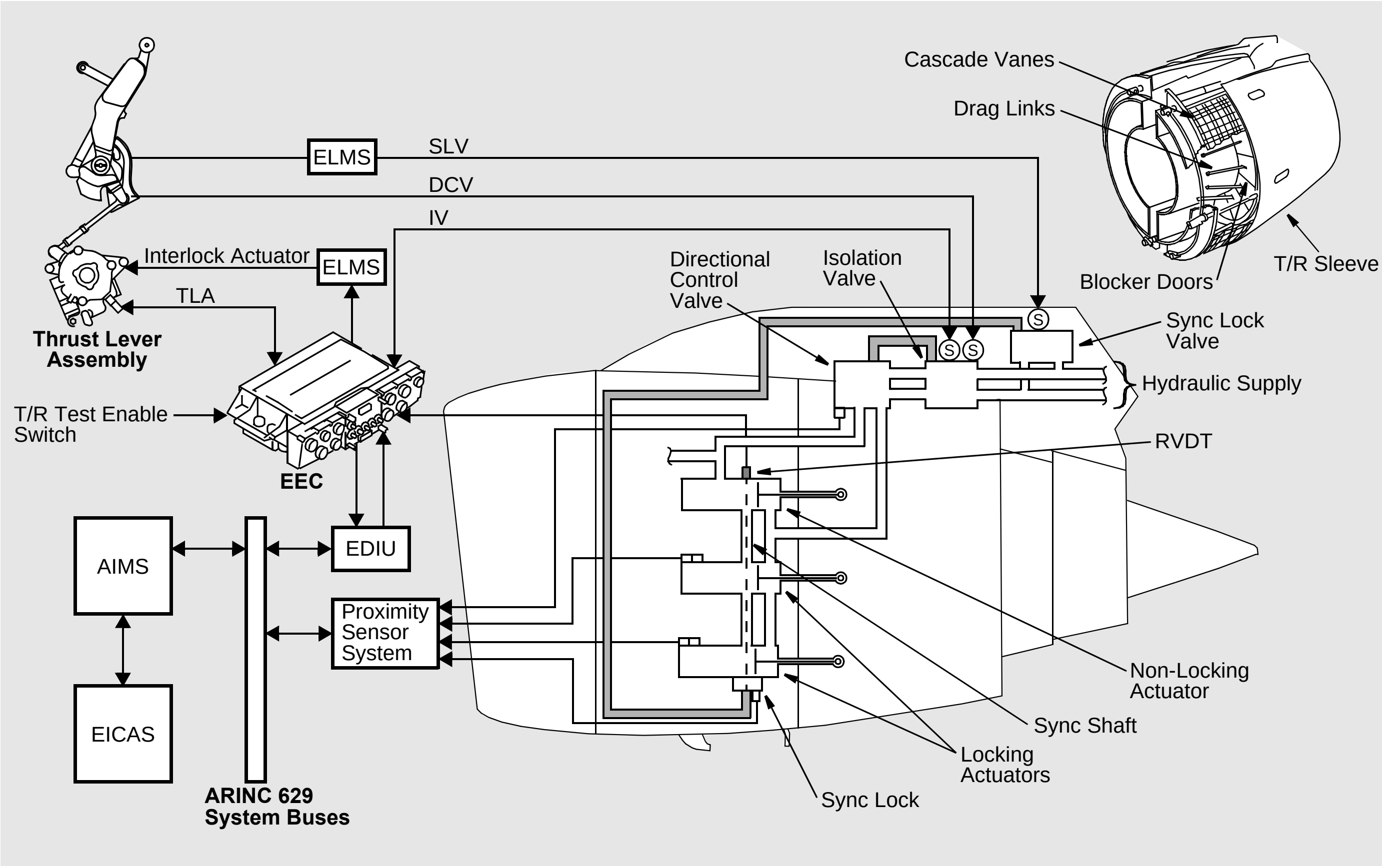
The scavenge subsystem removes oil and contaminants from the bearing compartments and gearboxes. The oil pump has a row of scavenge pumps. Each pump removes oil from its related bearing compartment or gearbox and sends it to the oil tank through the scavenge filter. Magnetic chip detectors remove ferrous particles from the scavenge oil.

BREATHER

The breather subsystem vents bearing seal pressurization air from the bearing compartments and oil tank. The engine breather in the external gearbox separates air from the oil. The air vents overboard while oil remains in the system.

INDICATION

The indication subsystem supplies oil pressure and temperature data through the EEC to the AIMS. The oil quantity transmitter has a direct analog connection to the AIMS. The secondary engine display shows oil pressure, temperature, and quantity. The EICAS display and the status display show fault messages. Oil data also shows on the maintenance pages.



Engine Exhaust System

Engine Exhaust System

The engine exhaust system controls the direction of exhaust gases to supply forward and reverse thrust.

The thrust reverser (T/R) system supplies reverse thrust to decrease the speed of the airplane on the ground. Fan exhaust turns forward during reverse thrust.

The T/R system is electrically controlled and hydraulically operated. You can operate it manually for maintenance.

COMPONENTS

There are two T/R halves on each engine. Each half includes:

- T/R sleeve
- Blocker doors
- Drag links
- Cascade segments
- Hydraulic actuators
- Synchronizing (sync) shaft and lock
- Proximity sensors.

These T/R system components are in the strut:

- Isolation valve (IV)
- Directional control valve (DCV)
- Sync lock valve (SLV).

System components in the flight deck include reverse thrust levers and interlock actuators below the control stand.

OPERATION

When you lift the reverse thrust lever, these three things occur:

- SLV releases the synch shaft lock
- DCV moves to the deploy position
- EEC commands reverse thrust.

The EEC controls the operation of the T/R. The IV supplies hydraulic pressure to the T/R system. The hydraulic actuators extend the T/R. When the reverser extends, the EEC energizes the interlock actuator. This permits more movement of the reverse thrust lever to increase reverse power.

When you put the reverse thrust lever in the down position, the T/R retracts. The locking actuators and synch shaft lock to keep the reverser in the stowed position.

A maintenance switch on the fan case permits a bypass of the EEC engine run logic to let the T/R deploy during maintenance.

RVDTs and proximity sensors monitor the T/R system for fault conditions. The RVDTs also supply signals for T/R control and flight deck indications.

SHOW PG MENU

EPCS PG 1/2

LEFT ENGINE A	B	TACH		RIGHT ENGINE A	B	TACH
19.5	19.5	19.5	N_1	19.4	19.4	19.4
46.3	46.3	0.0	N_2	46.1	46.1	0.0
60.3	60.3	60.3	N_3	60.4	60.4	60.4
33.9	33.9		TRA	34.0	34.0	
0.0	0.0		T/R_L	0.0	0.0	
0.0	0.0		T/R_R	0.0	0.0	
14.7	14.7		P_{AMB}	14.7	14.7	
52	52		P_{30}	52	52	
14.7	14.7		P_{20}	14.7	14.7	
10	10		T_{20}	12	12	
37.1	36.9		VSV	37.0	36.2	
11	11		T24	12	12	
101	101		OIL T	101	100	
59	61		OIL P	62	61	
32.7	32.7		FMV	32.2	32.2	

ENG OIL TEMP L DATE 16 SEP 980 UTC 18:54:04

SHOW PG MENU

EPCS PG 2/2

LEFT ENGINE A	B		RIGHT ENGINE A	B
347	347	EGT	344	344
15	15	EEC TEMP	15	15
15	15	P50	15	15
3060	3040	STATUS 1	3060	3040
0E00	0E00	STATUS 2	0E00	0E00
0008	0008	STATUS 3	0008	0008
4200	4200	STATUS 4	4400	4400
00A0	00A0	STATUS 5	00A0	00A0
0010	0010	STATUS 6	0010	0010
0020	0020	STATUS 7	0020	0020
BA28	BA28	STATUS 8	BA28	BA28

ENG OIL TEMP L DATE 16 SEP 98 UTC 18:54:04

Maintenance Pages

Auxiliary Power Unit

- **Auxiliary Power System**
- **Control and Indication**
- **Fuel System**
- **Pneumatic System**
- **Ignition and Starting System**
- **Lubrication System**

Features

OPERATES ON THE GROUND OR IN FLIGHT

The auxiliary power unit (APU) is an electrical and pneumatic power source for aircraft systems on the ground or in flight.

PNEUMATIC POWER SOURCE

The APU load compressor supplies pneumatic power up to an altitude of 22,000 feet (6700 m).

ELECTRICAL POWER SOURCE

A 120 kVA APU generator supplies electrical power up to the service ceiling of the airplane.

DUAL STARTING SYSTEM

The APU has an electric and an air turbine starter. The air turbine starter starts the APU when there is pressure in the pneumatic system.

EDUCTOR COOLING SYSTEM

The APU eductor air/oil cooling system replaces the more usual mechanical fan.

AUTOSTART

The APU automatically starts if the airplane is in the air and both the left and right transfer buses lose power.

FULL AUTHORITY DIGITAL ELECTRONIC CONTROL

The APU control system uses microprocessor electronics to supply automatic, full-authority digital electronic control for all APU operating conditions.

DUAL OPERATING MODES

The APU may operate in either the attended or unattended mode. In the attended mode, only safety related faults cause automatic protective shutdowns. In the unattended mode, all faults that may damage the APU cause protective shutdowns.

OPERABLE DURING REFUELING

The APU operates normally during refueling operations.

CLUSTER COMPONENT DESIGN

For easier line maintenance, these subsystem components are in functional clusters:

- Fuel
- Lubrication
- Ignition
- Pneumatic.

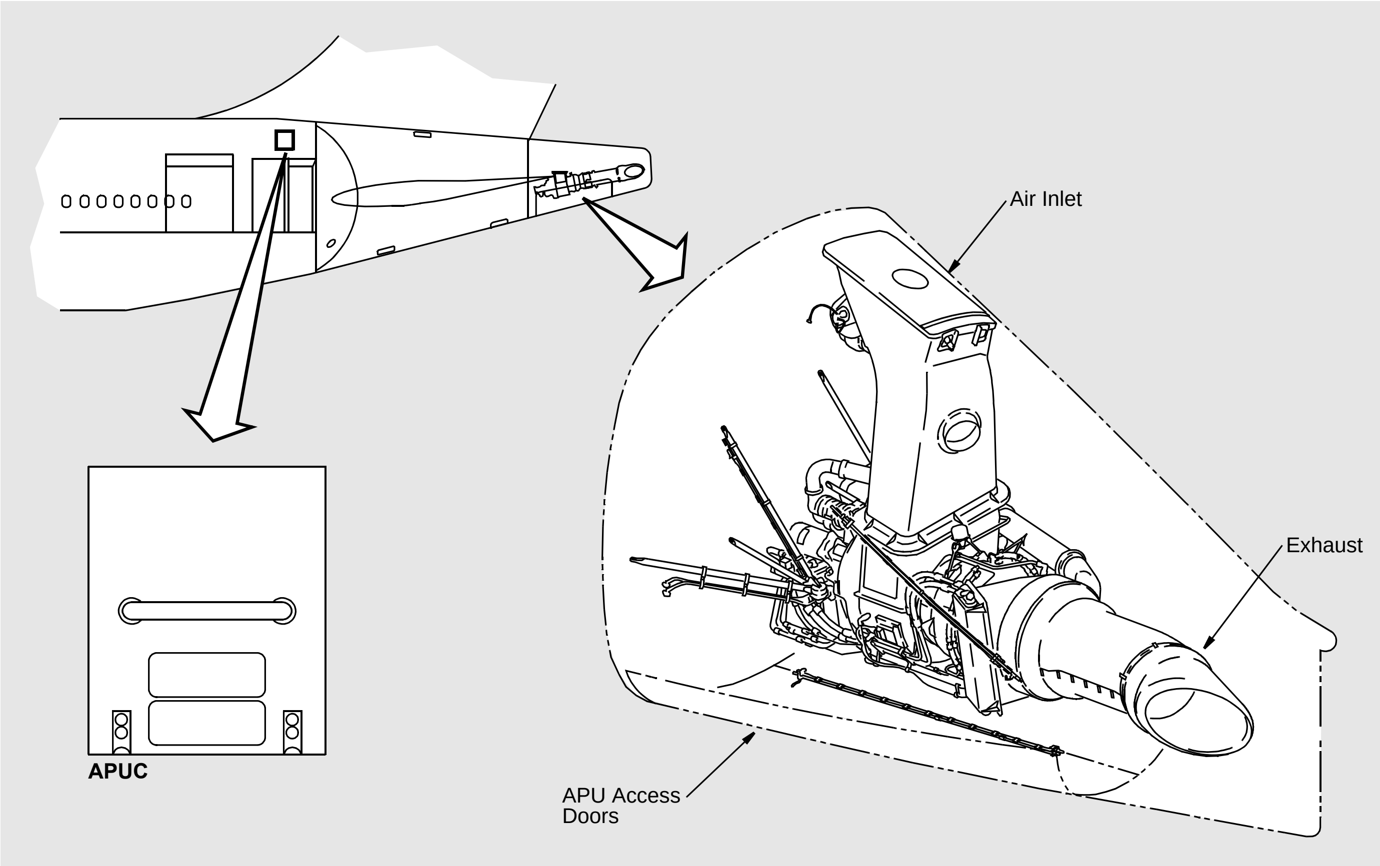
The clusters are line replaceable units.

OPERATIONAL HISTORY RECORDING

A data memory module records APU operation data.

OPTIONAL EXHAUST MUFFLER

An optional exhaust muffler in the exhaust duct decreases exhaust noise.



Auxiliary Power System

Auxiliary Power System

The auxiliary power system supplies electrical and pneumatic power to the airplane. This permits independent ground operation. The auxiliary power system is also available for use in flight.

The auxiliary power unit (APU) is an AlliedSignal Engines 331-500. The APU is in the tail cone of the aircraft.

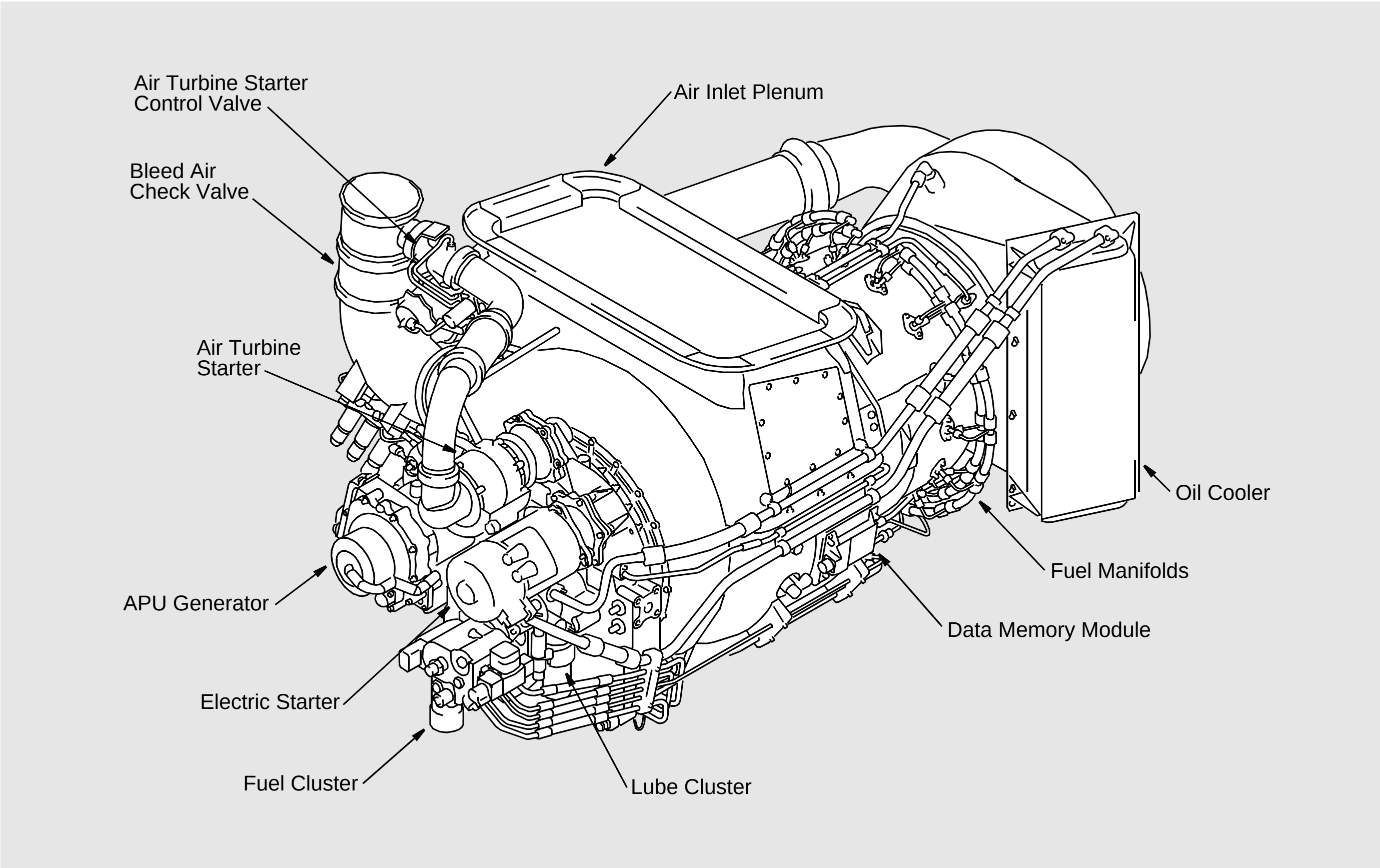
The APU controller (APUC) controls and monitors the APU starting sequence, normal operation, and shutdown. The APUC does protective shutdowns, if necessary, to prevent damage to the APU.

The APU can start at all altitudes up to the service ceiling of the airplane (43,100 feet / 13,100m). Electrical power is available up to the service ceiling and pneumatic power is available up to 22,000 feet (6700m).

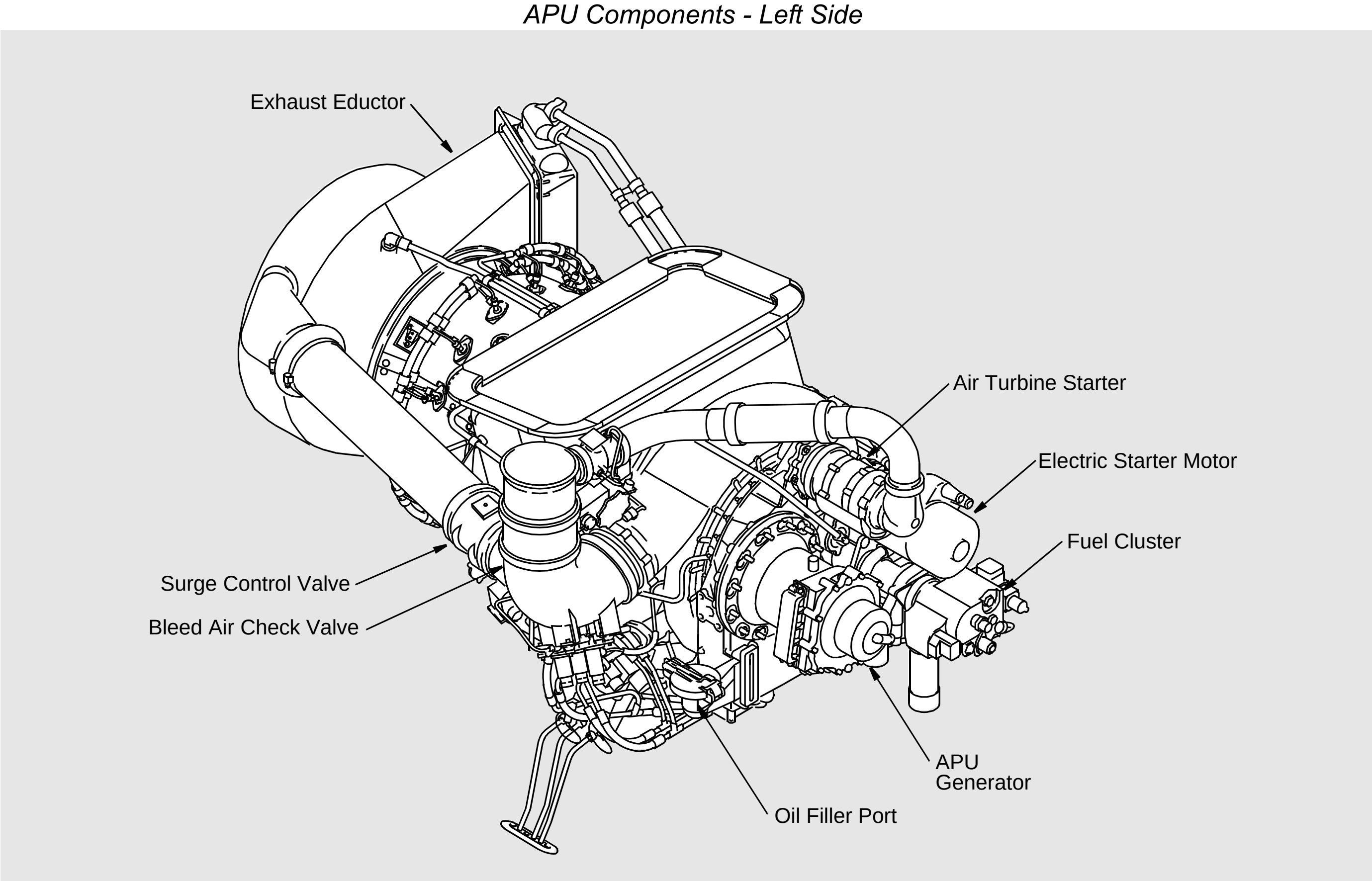
To make maintenance easier, some subsystem components are in removable clusters.

A data memory module (DMM) attaches to the left side of the APU inlet plenum. The DMM makes a record of this APU operation data:

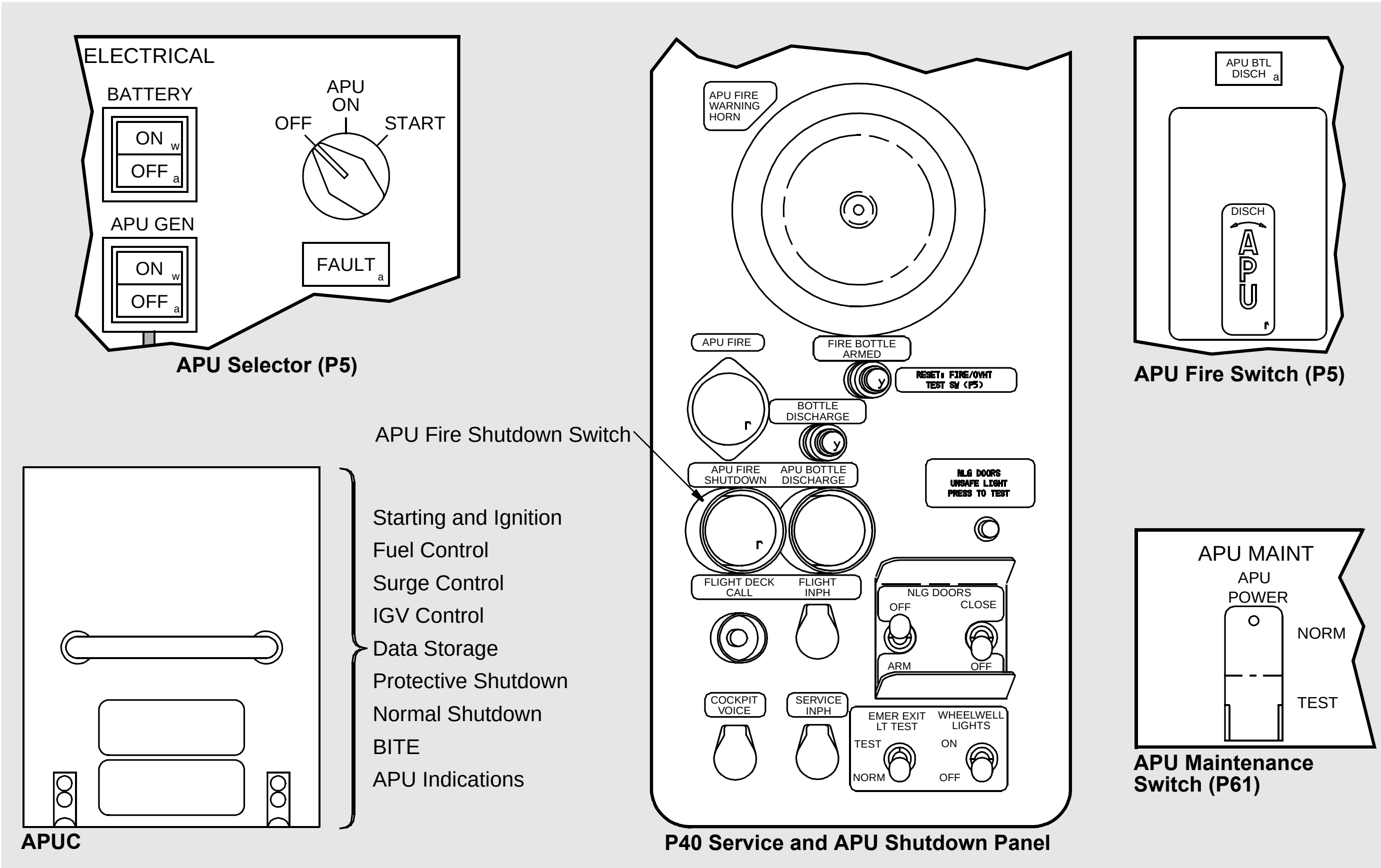
- Number of starts
- Type of start (electric or pneumatic)
- Operating hours
- Time in the different operating modes
- Average generator load.



APU Components - Left Side



APU Components - Right Side



APU Control and Indication

Control and Indication

CONTROL

The APUC controls these APU functions:

- Starting and ignition
- Fuel control
- Surge control
- Inlet guide vane (IGV) control
- Data storage
- Protective shutdowns
- Normal shutdowns
- Bite/Fault reporting
- APU indications.

The APU selector is on the electrical panel on the P5 overhead panel. You use this selector for normal APU start and shutdown.

The APU fire switch on the P5 overhead panel or the APU fire shutdown switch on the P40 service and APU shutdown panel are for emergency shutdown.

The APU maintenance switch on the P61 overhead maintenance panel lets you supply power to the APUC when the APU selector is OFF.

INDICATION

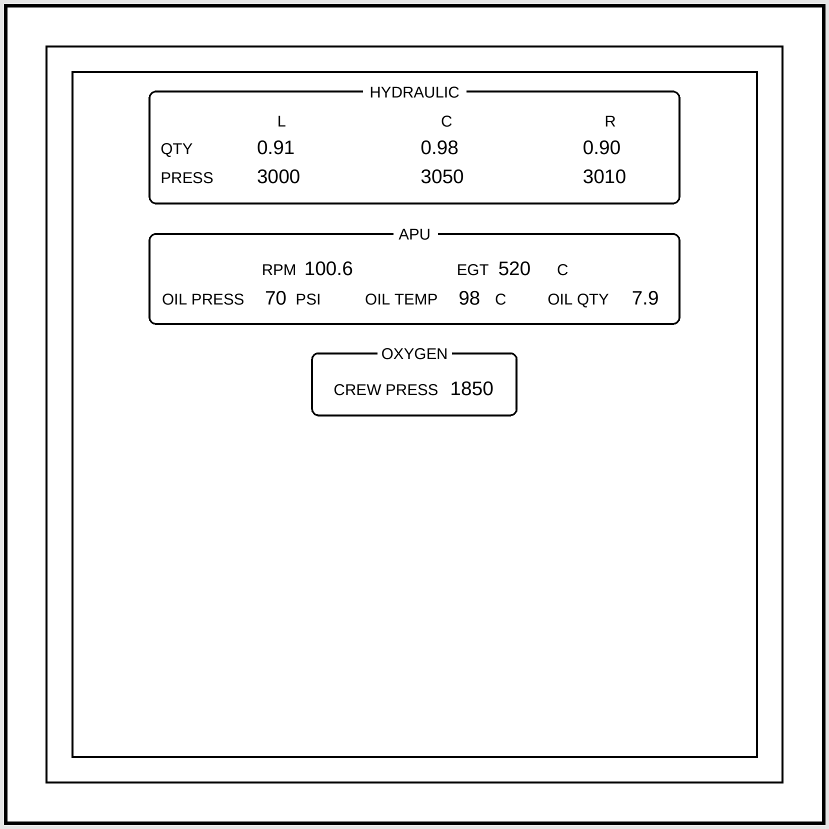
The EICAS display shows an APU RUNNING memo message when the APU is on.

The status display normally shows this APU data:

- Exhaust gas temperature
- Speed
- Lubrication system status.

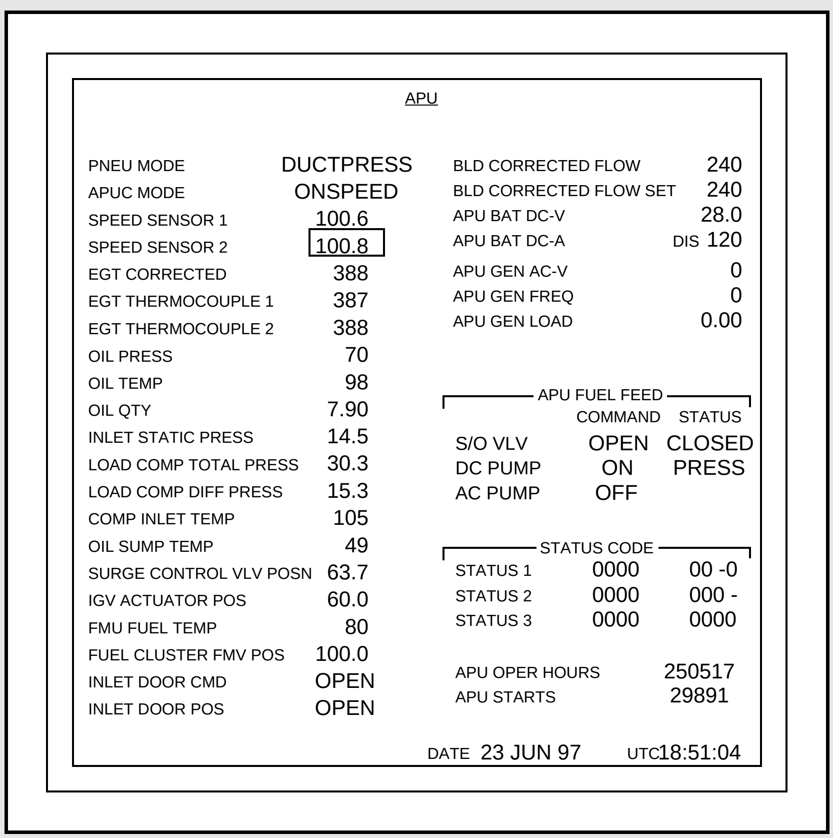
The APU maintenance page shows the output of the APU sensors and other APU data.

A fault light below the APU selector comes on when the APU does a protective shutdown. The fault light also flashes during APU start and shutdown to show the APUC self-test BITE.



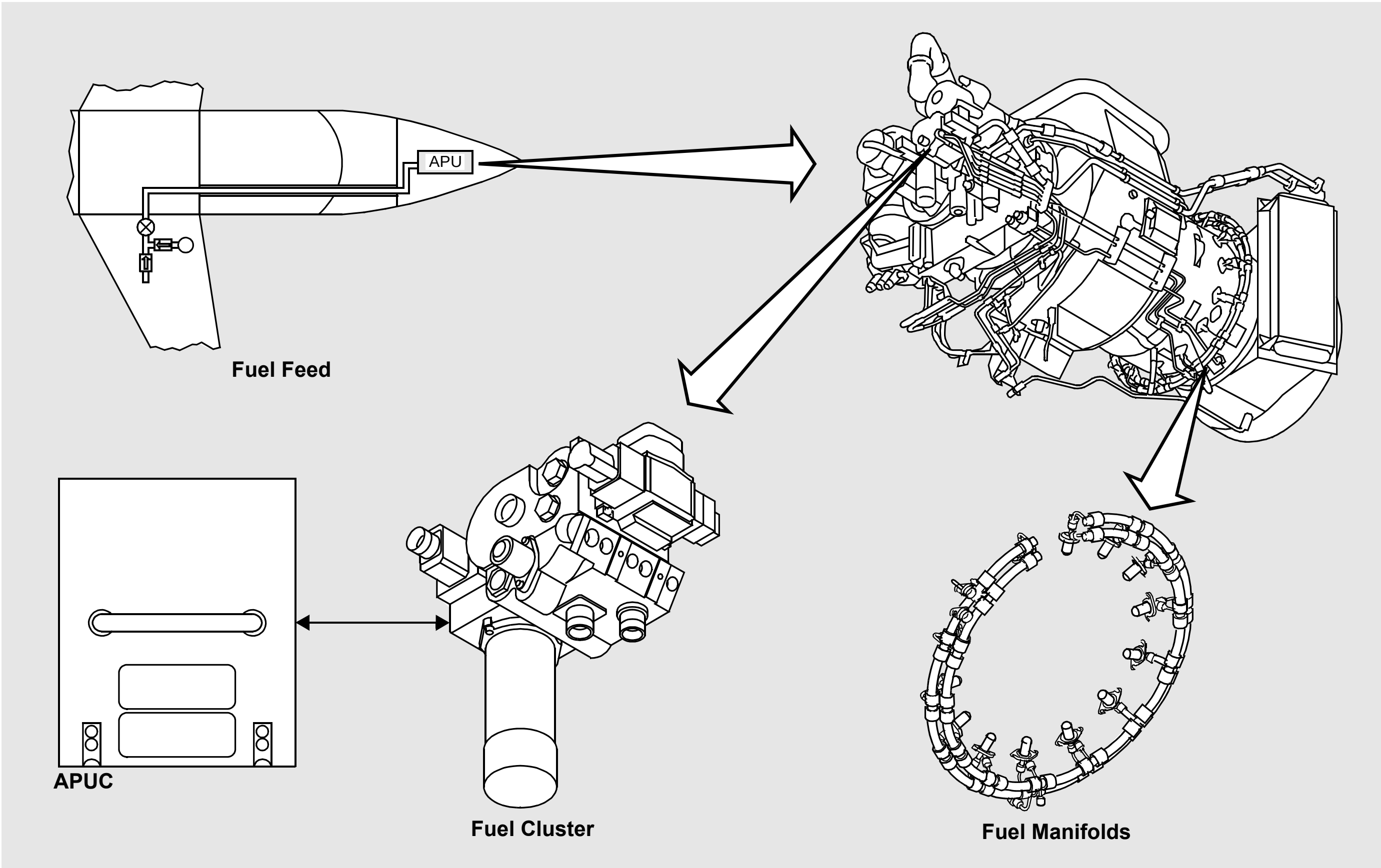
Status Display

Primary Display System Indications



APU Maintenance Page

Primary Display System Indications



APU Fuel System

Fuel System

The APU fuel system gets fuel from the left main tank and supplies it to the APU for combustion. These are the main components of the fuel system:

- Fuel cluster
- Fuel manifolds.

To make maintenance easier, many of the fuel system components are in a cluster. The fuel cluster has these components:

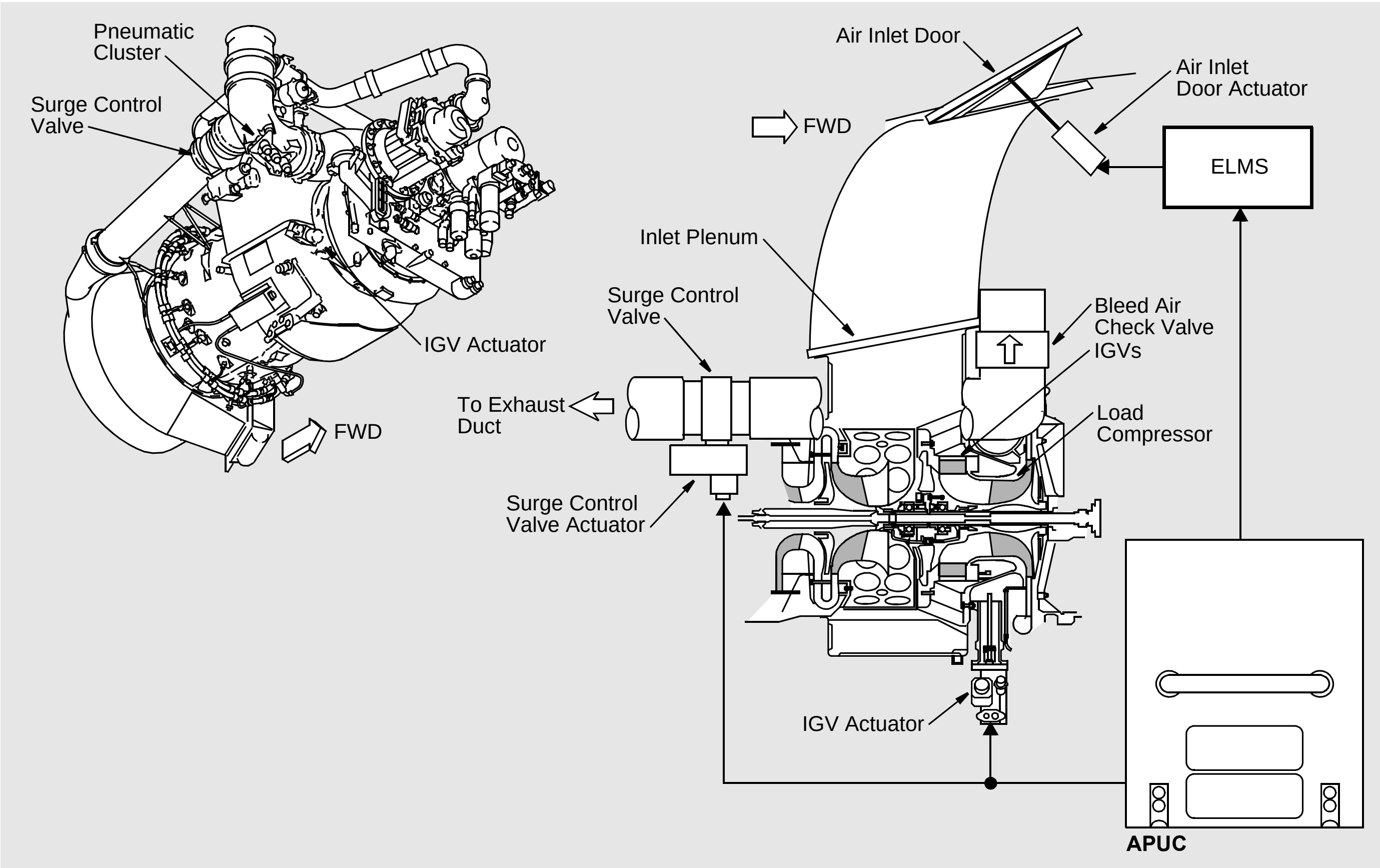
- Boost and pressure pumps
- Fuel filter
- Pressure regulator
- Pressure relief valve
- Fuel metering section
- Flow divider
- Fuel shutoff valve
- Fuel temperature sensor.

The APUC sends fuel control signals to the fuel cluster for normal operation. The APUC also controls fuel flow during start and shutdown (both normal and protective), and adjusts APU generator speed for no-break electrical power transfers.

The APU fuel cluster pressurizes, filters, and meters the fuel flow. The fuel flow divider separates the metered fuel into the primary and secondary fuel manifolds for supply to the combustion chamber. The secondary fuel manifold operates after the APU speed increases to more than 50 percent RPM to supply more fuel flow.

Regulated (servo) fuel pressure operates the inlet guide vane actuator and the surge control valve actuator.

Overspeed causes fuel system protective shutdowns. No light-off and no acceleration cause protective shutdowns in the unattended mode only.



APU Pneumatic System

Pneumatic System

The APU supplies pressurized air for these pneumatic system functions:

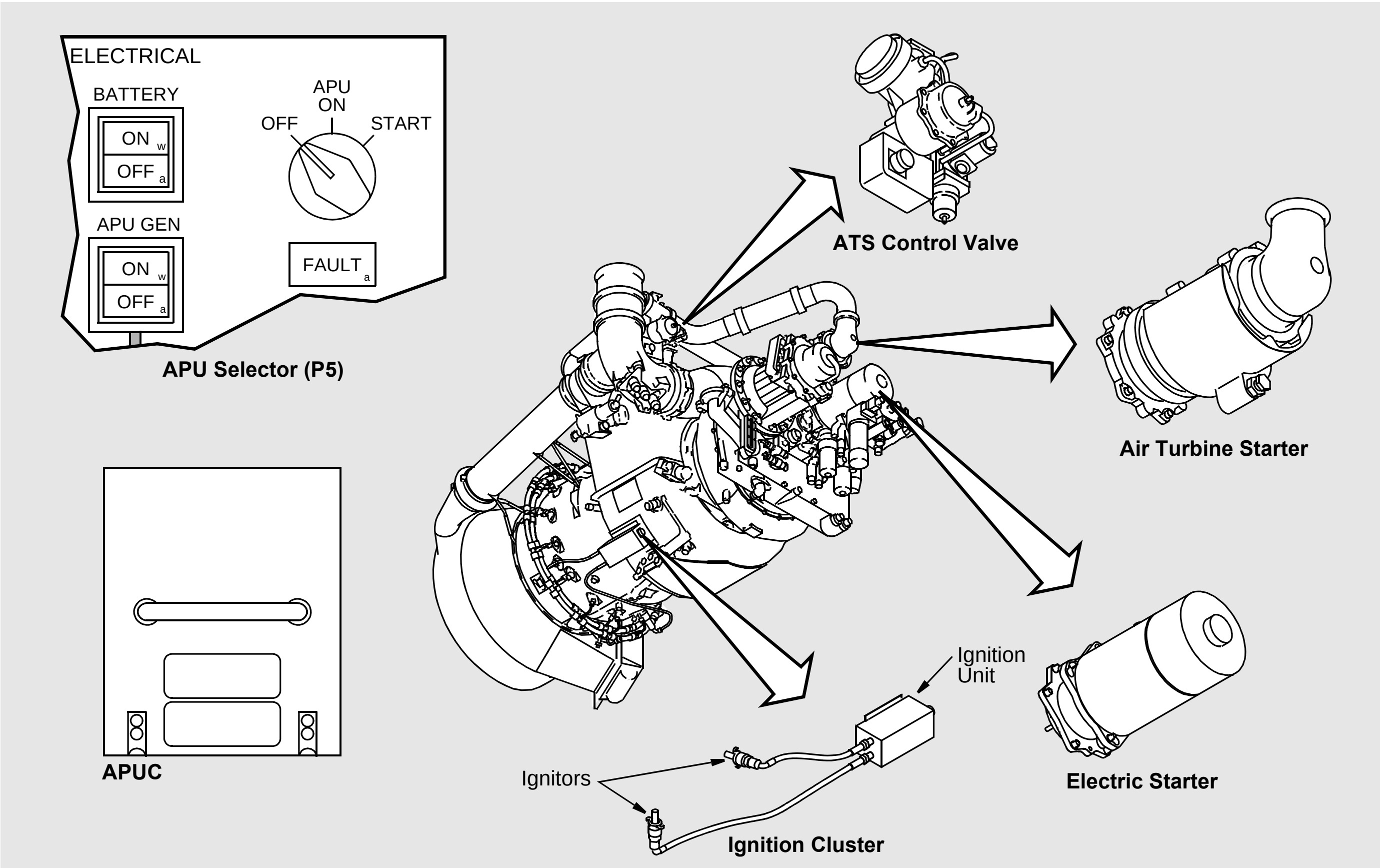
- Environmental control system (ECS)
- Air driven hydraulic pumps (ADPs)
- Main engine start (MES)
- Wing anti-ice.

The electrical load management system (ELMS) controls the operation of the air inlet door. Air comes into the APU inlet air plenum from the air inlet door. The load compressor gets air from the plenum through variable inlet guide vanes (IGVs). The IGVs control the volume of air available to the load compressor. The load compressor sends pressurized air into the pneumatic ducts.

The APUC controls the IGVs as a function of how the airplane systems use pressurized air. High pressure fuel supplies the force that operates the IGVs.

A surge control valve sends any unneeded pressurized air into the APU exhaust. The APUC controls the surge control valve. High pressure fuel supplies the force that operates the surge control valve. A bleed air check valve prevents reverse pressurized air flow from the airplane system.

To make maintenance easier, some pneumatic components are in a cluster. The cluster includes three pneumatic pressure sensors and the surge control valve that mounts on a section of the bleed air duct.



APU Ignition and Starting System

Ignition and Starting System

The ignition and starting system supplies the combustion spark and starts the APU acceleration. These are the components of the ignition and starting system:

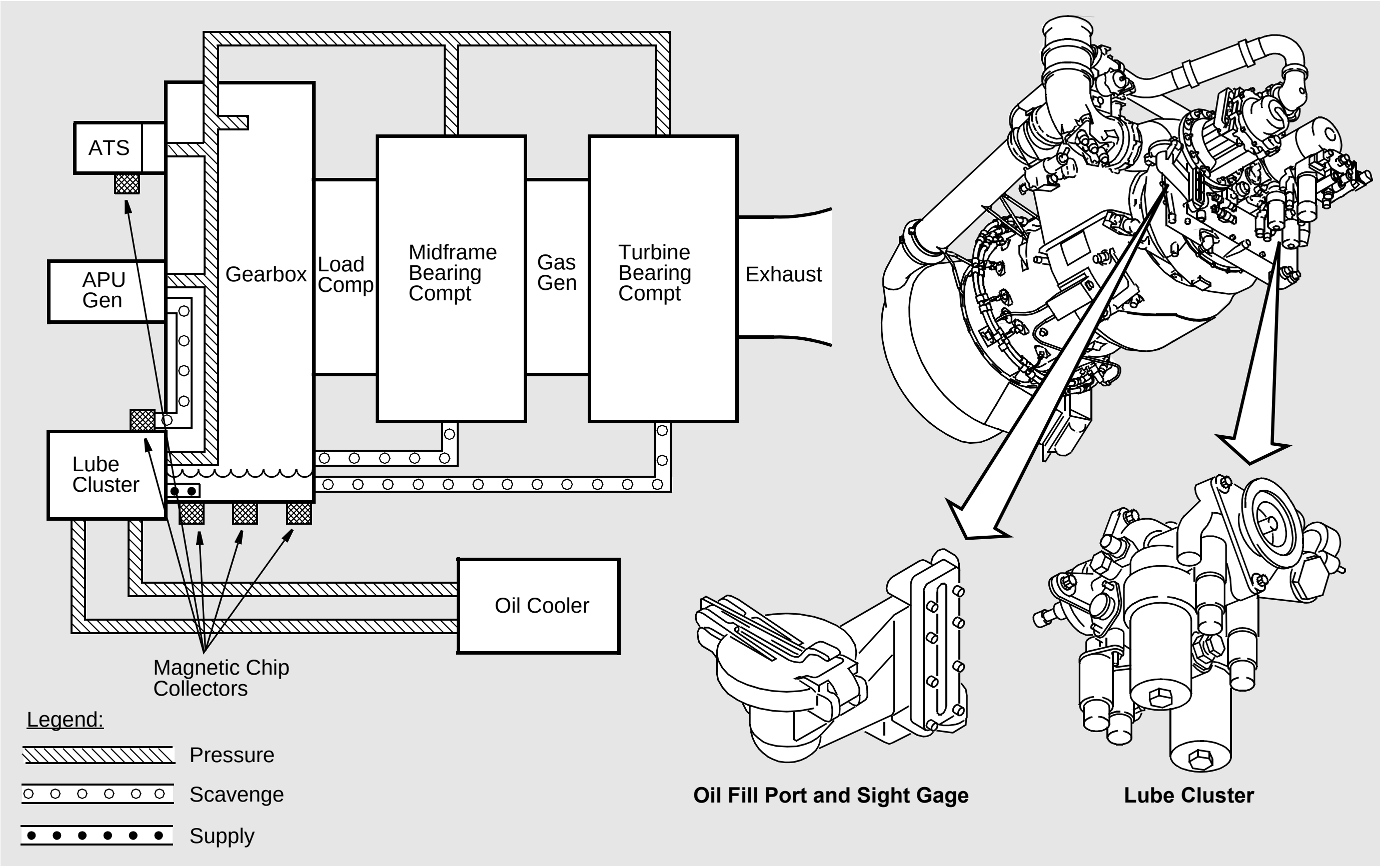
- Air turbine starter (ATS) control valve
- Air turbine starter
- Electric starter
- Ignition unit
- Dual ignitors.

One of the two starters starts the APU. The pneumatic starter operates when pressurized air is available. If pressurized air is not available, the electric starter starts the APU.

The ignition components are in a cluster.

The ignition unit supplies energy to the two ignitors. The APUC controls the power to the ignition unit. The ignitors supply the spark to the combustion chamber.

Automatic starting of the APU occurs when transfer bus power is lost in the air.



APU Lubrication System

Lubrication System

The APU lubrication system removes heat and lubricates these components:

- APU generator
- Air turbine starter
- APU gearbox
- APU bearings.

These lubrication system components are in the lube cluster:

- Pressure and scavenge pumps
- Oil filters
- Pressure and temperature sensors.

These are the other lubrication system components:

- Oil cooler
- Magnetic chip collectors
- Oil heater assembly.

The APU oil supply is in the gearbox sump. Oil servicing is through a pour-type fill port. A sight glass shows oil quantity. A transmitter sends oil quantity data to the APUC.

Cooled and filtered pressurized oil goes to the bearings, the generator, and the accessory section gearbox.

Scavenge pumps send oil back to the reservoir from the turbine and load compressor bearings. Scavenge pumps also send back filtered oil from the generator to the reservoir.

The APU exhaust gas operates an eductor that pulls APU compartment air through the oil cooler.

Five magnetic chip collectors collect metallic particles in the APU lubrication system.

Hydraulics

Features

TRIPLE REDUNDANCY

There are three independent hydraulic systems. Each system has two or more pumps that operate from different pneumatic, mechanical, or electrical power sources.

Each hydraulic system can independently operate the flight controls for safe flight and landing.

PUMP OPERATION ON DEMAND

Normally, one or two pumps in each hydraulic system operate continuously. The other pumps operate only when there is a hydraulic demand. This increases pump life, system efficiency, and reliability.

AUTOMATIC SYSTEM CONTROLS

The flight crew sets the pump switches for flight before engine start. Normally no further action is necessary. The demand pumps operate automatically.

Each hydraulic system uses hydraulic interface module electronic cards for automatic control, fault detection, and indications.

RAM AIR TURBINE

If all usual pressure sources become unavailable during flight, the ram air turbine is an emergency source of hydraulic power for the primary flight controls.

TUBE SEPARATION

The location of the hydraulic system tubes decreases the risk of multiple system losses from a single failure source. Only one hydraulic system has tubes in an engine strut and nacelle. Only two systems go to the end of the wings.

Left and right system tubes are on opposite sides of the body. In the wheel wells, there is maximum separation of tubes. In the wings, one system is forward of the rear spar and two systems are aft of the rear spar.

CENTER HYDRAULIC ISOLATION SYSTEM

A center hydraulic isolation system (CHIS) supplies a reserve brake and steering function if there is a loss of center hydraulic system fluid.

HYDRAULIC FUSES

Hydraulic fuses in some of the hydraulic lines to these systems protect against fluid loss:

- Main Gear Steering
- Brakes
- Main Gear Actuation
- Flight Controls.

COMPONENTS GROUPING

Hydraulic reservoirs are near the pumps they supply. Pump filter modules are close to each pump. Return filter modules are close to each reservoir.

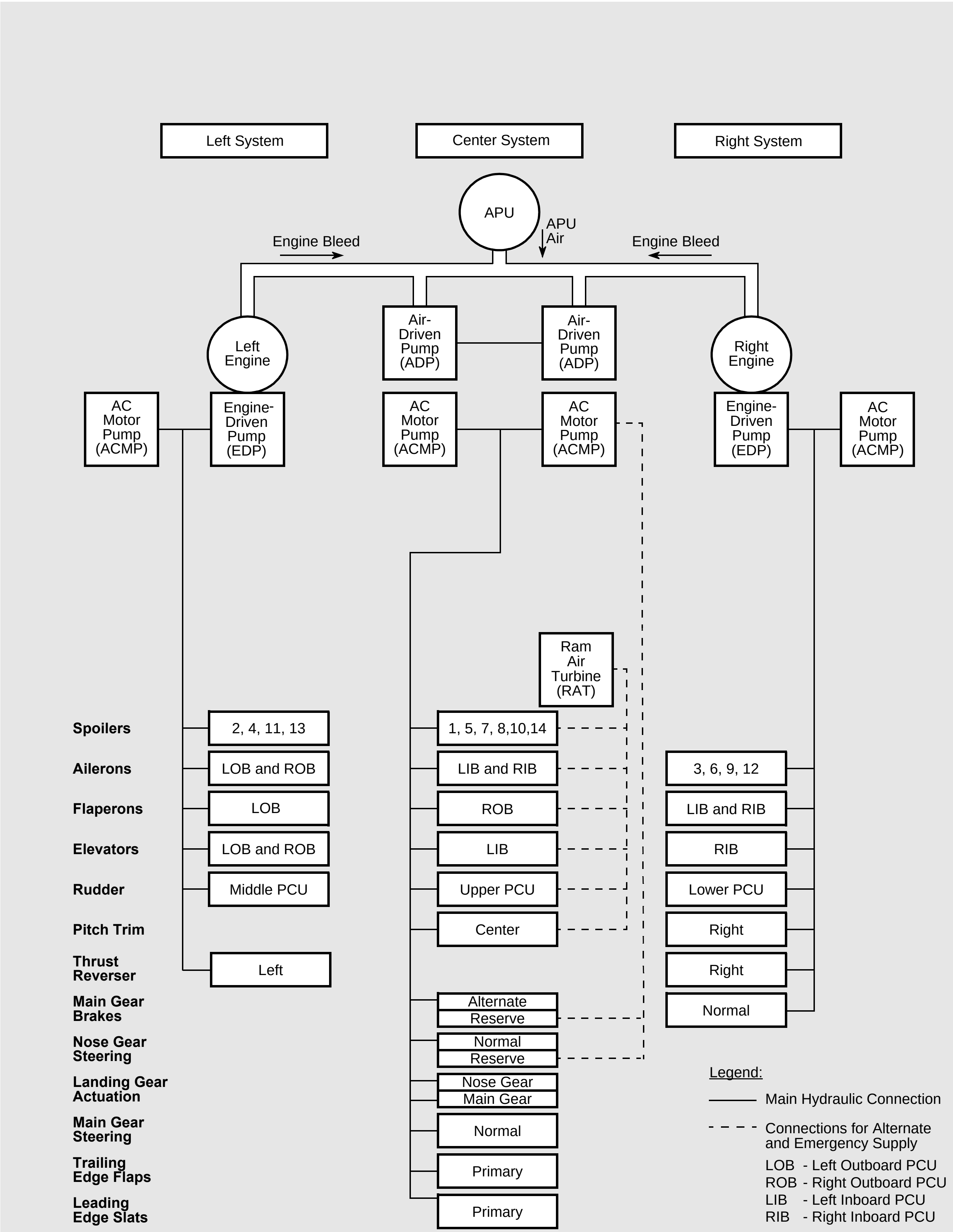
COMMONALITY OF COMPONENTS

All electric pumps are interchangeable. The air-driven pumps and engine-driven pumps are also interchangeable. The pressure and case drain filter modules are the same for the engine-driven pumps and the air-driven pumps. The pressure and case drain filter modules are the same for all electric pumps.

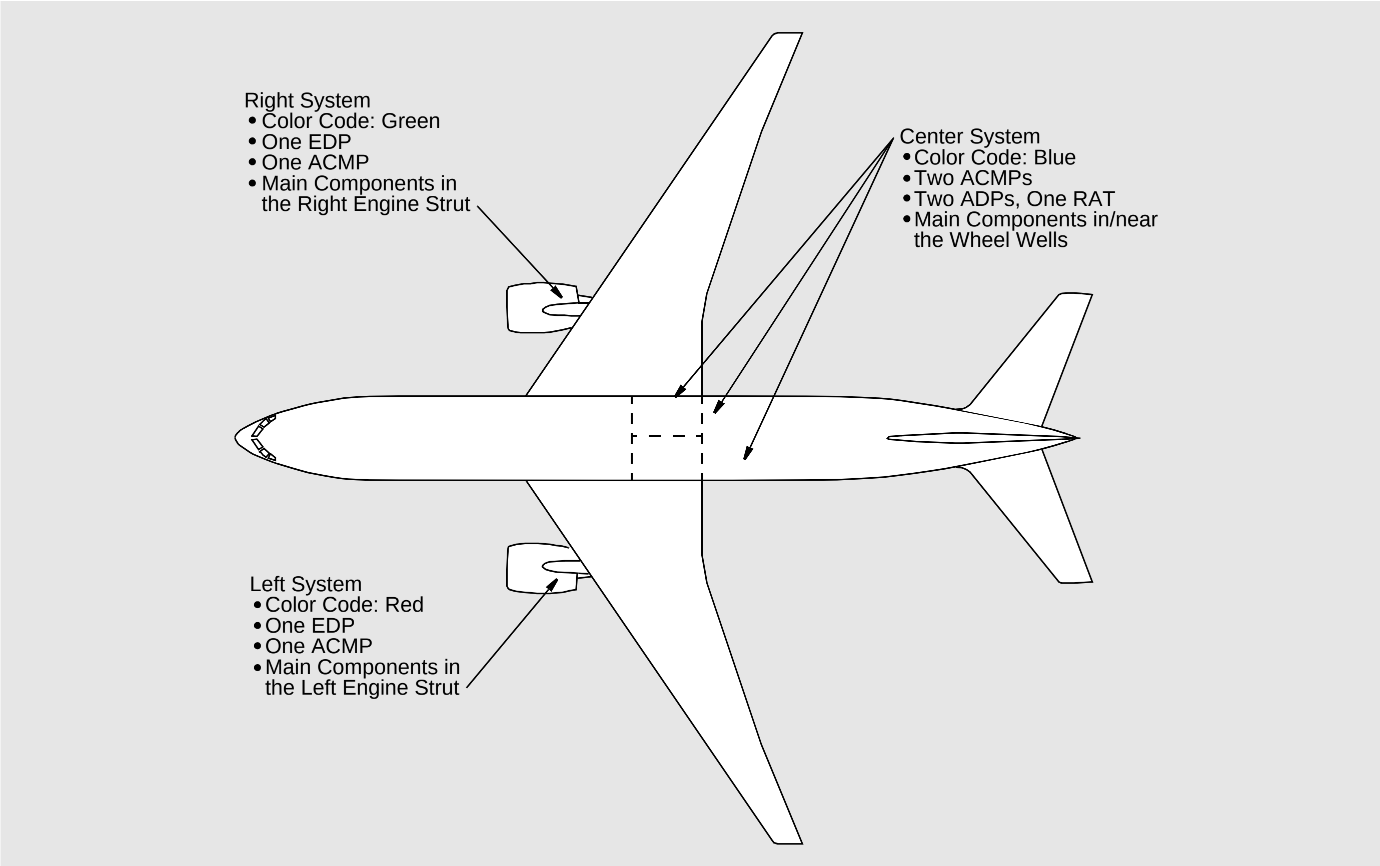
SINGLE-POINT RESERVOIR SERVICING

A hydraulic reservoir servicing station in the right aft body fairing makes it possible to fill all three reservoirs from one location.

- **Hydraulic Systems**
- **Controls and Indications**
- **Automatic Control**
- **Reservoir Servicing Station**
- **Maintenance Panel**



Hydraulic System Block Diagram



Hydraulic Systems Component Locations

Hydraulic Systems

The three hydraulic systems operate independently at 3,000 psi nominal pressure. The three systems are named left (L), center (C) and right (R) for the location of their main components. Each system has its own reservoir, pumps, and filters.

The left system has an engine-driven pump (EDP) and an alternating-current motor pump (ACMP). The right AC bus supplies power to the ACMP. The left system supplies power to the flight controls and the left thrust reverser.

The right system also has an EDP and an ACMP. The left AC bus supplies power to the ACMP. The right system supplies power to the flight controls, the normal main gear brakes, and the right thrust reverser.

The center system has two ACMPs, two air-driven pumps (ADPs) and a ram air turbine (RAT) pump. The left and right AC buses supply power to the ACMPs. Pneumatic power from the two engines or the auxiliary power unit (APU) operates the ADPs.

The center system supplies power for these functions:

- Flight controls
- Leading edge slats
- Trailing edge flaps
- Alternate and reserve main gear brakes
- Normal and reserve nose gear steering and nose gear extension-retraction
- Main gear extension-retraction
- Main gear steering.

The RAT deploys automatically during flight when any of these conditions occur:

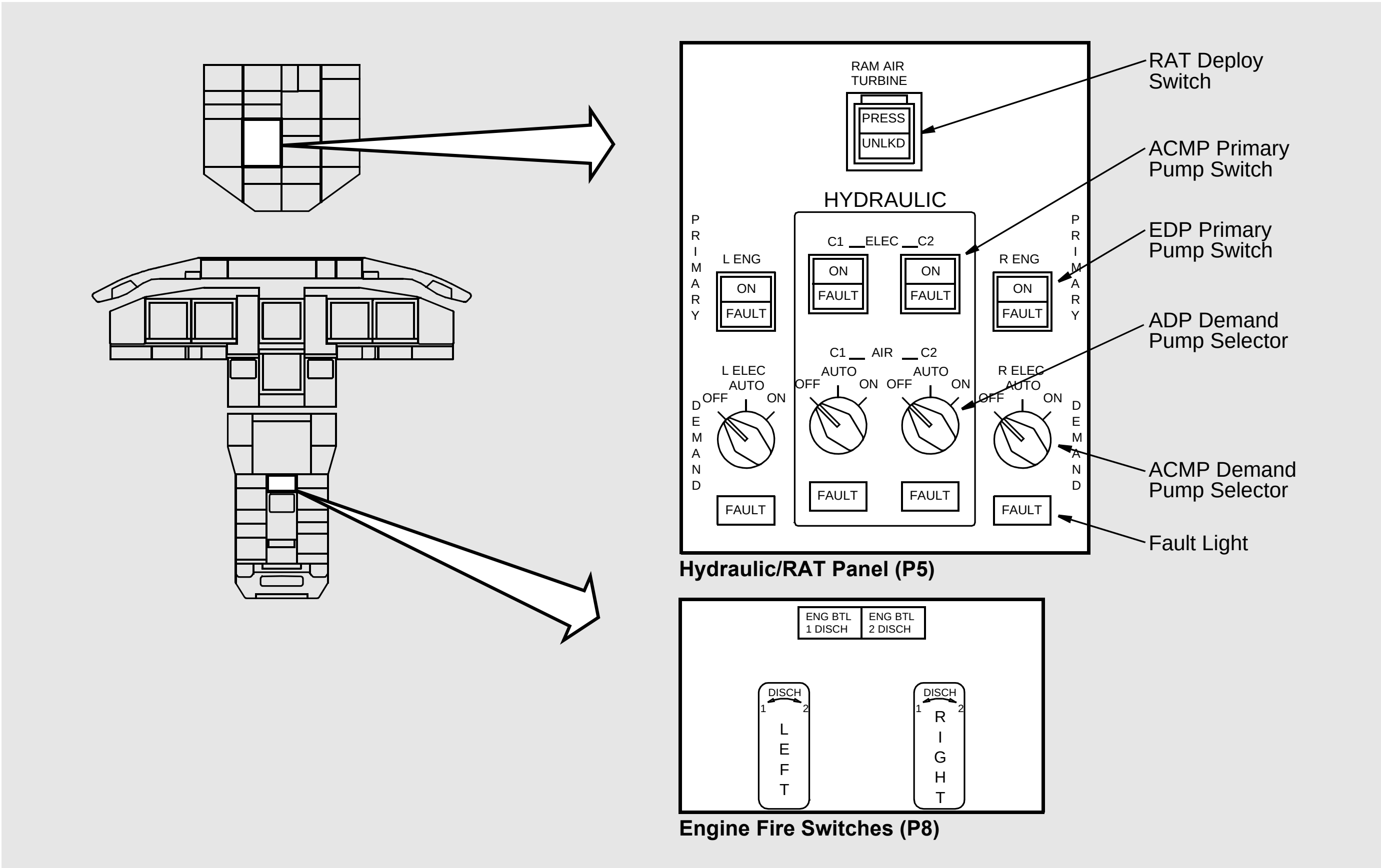
- Both engines are shut down
- Both AC buses are not powered
- All three hydraulic system pressures are low.

Ram air then turns the turbine. Only the flight controls use hydraulic power from the RAT. The RAT can be retracted only on the ground.

PRIMARY AND DEMAND PUMPS

The primary pumps are the EDPs in the left and right systems and the ACMPs in the center system. These pumps operate continuously.

The demand pumps are the ACMPs for the left and right systems and the ADPs for the center system. These pumps normally operate only during heavy system demands.



Controls and Indications

Controls and Indications

The hydraulic pump controls and indication lights are on the P5 overhead panel.

PUMP MANUAL CONTROLS

Pump controls on the Hydraulic/RAT panel permit manual control of the hydraulic systems.

The primary pump switches have ON and OFF positions. Primary pumps are normally ON.

Demand pump selectors may be set to OFF, AUTO, or ON. To permit automatic pump control, demand pumps are normally set to AUTO.

RAT MANUAL CONTROL

The RAT deploy switch, on the upper part of the hydraulic /RAT panel, permits the flight crew to manually deploy the ram air turbine.

INDICATING LIGHTS

Each pump has an amber fault light which shows a pump overheat or low pressure condition. The RAT switch has a green light which shows high RAT output pressure and an amber light which shows the RAT is unlocked.

ENGINE FIRE SWITCHES

The engine fire switches shut off hydraulic fluid supply to the EDPs. The engine fire switches are on the P8 aft control stand.

PRIMARY DISPLAY SYSTEM INDICATIONS

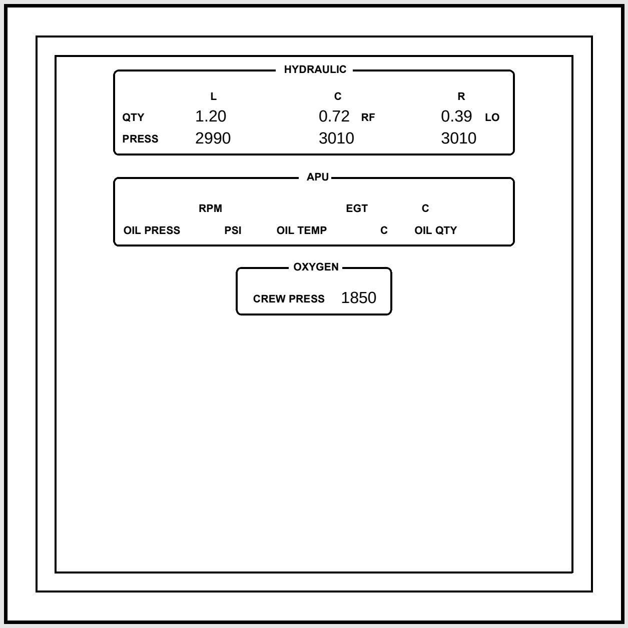
These conditions cause alert level EICAS indications:

- RAT unlocked
- Low system pressure
- Low pump pressure
- Pump overheat
- Reservoir low quantity
- Reserve brake and steering failure
- HYDIM card failure.

The status display shows reservoir quantity and system pressure for each system.

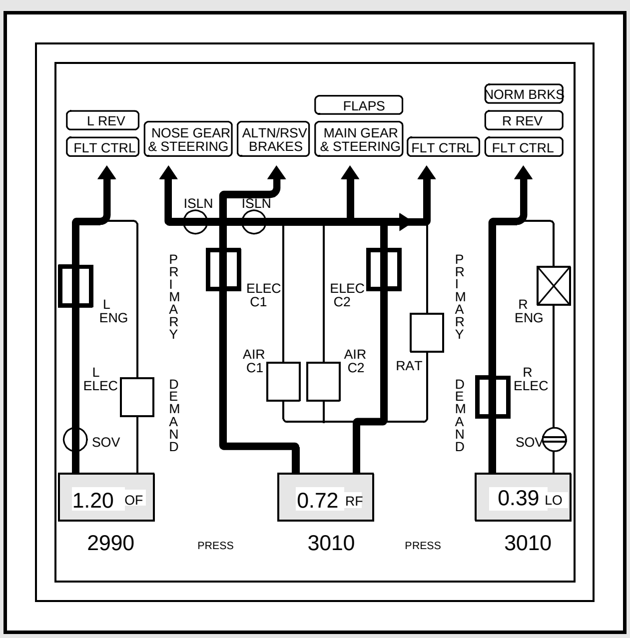
The hydraulic synoptic display is a real-time diagram of the operational status of the hydraulic system.

The hydraulic maintenance page shows hydraulic data for maintenance personnel.

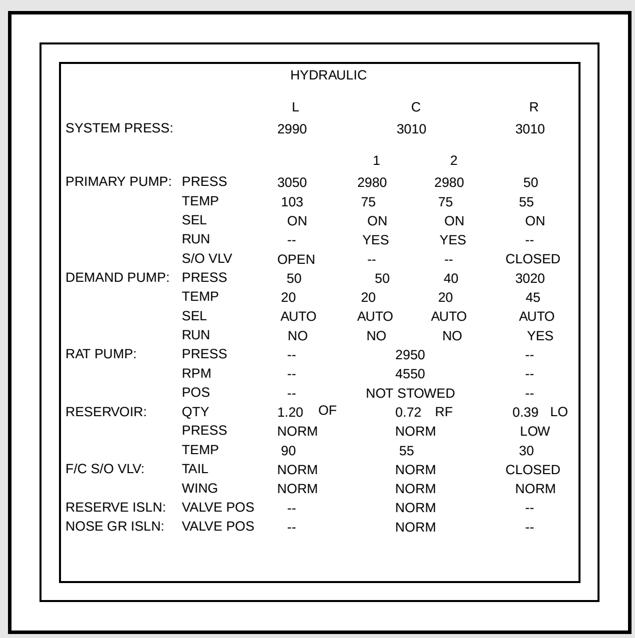


Status Display

Hydraulic Status Page



Hydraulic Synoptic Display

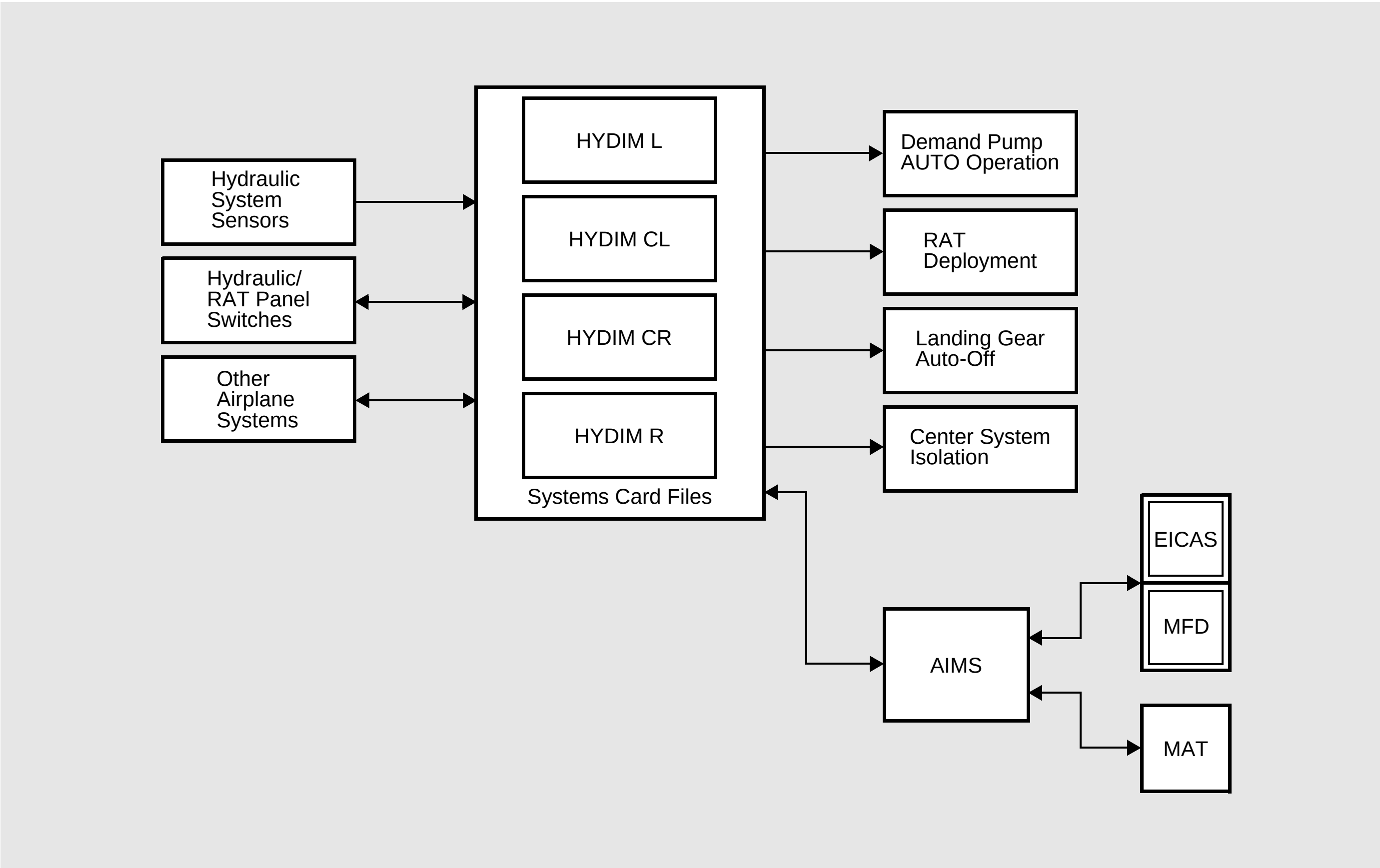


HYDRAULIC

		L	C 1	C 2	R
SYSTEM PRESS:		2990	3010		3010
PRIMARY PUMP:	PRESS	3050	2980	2980	50
	TEMP	103	75	75	55
	SEL	ON	ON	ON	ON
	RUN	--	YES	YES	--
	S/O VLV	OPEN	--	--	CLOSED
DEMAND PUMP:	PRESS	50	50	40	3020
	TEMP	20	20	20	45
	SEL	AUTO	AUTO	AUTO	AUTO
	RUN	NO	NO	NO	YES
RAT PUMP:	PRESS	--	2950		--
	RPM	--	4550		--
	POS	--	NOT STOWED		--
RESERVOIR:	QTY	1.20 OF	0.72 RF		0.39 LO
	PRESS	NORM	NORM		LOW
	TEMP	90	55		30
F/C S/O VLV:	TAIL	NORM	NORM		CLOSED
	WING	NORM	NORM		NORM
RESERVE ISLN:	VALVE POS	--	NORM		--
NOSE GR ISLN:	VALVE POS	--	NORM		--

Hydraulic Maintenance Page

Hydraulic Synoptic and Maintenance Pages



Hydraulic Control Interfaces

Automatic Control

HYDIM CARDS

Hydraulic interface module (HYDIM) cards control the hydraulic system operation and indication. These cards are in the systems card files in the main equipment center. There is one card for the left system (HYDIM L), two for the center system (HYDIM CL and CR) and one for the right system (HYDIM R).

The HYDIM cards send data to the airplane information management system (AIMS) through ARINC 629 buses.

HYDIM FUNCTIONS

The HYDIM cards control these functions:

- Demand pump AUTO operation
- Rat deployment
- Landing gear Auto-Off operation
- Center hydraulic system isolation.

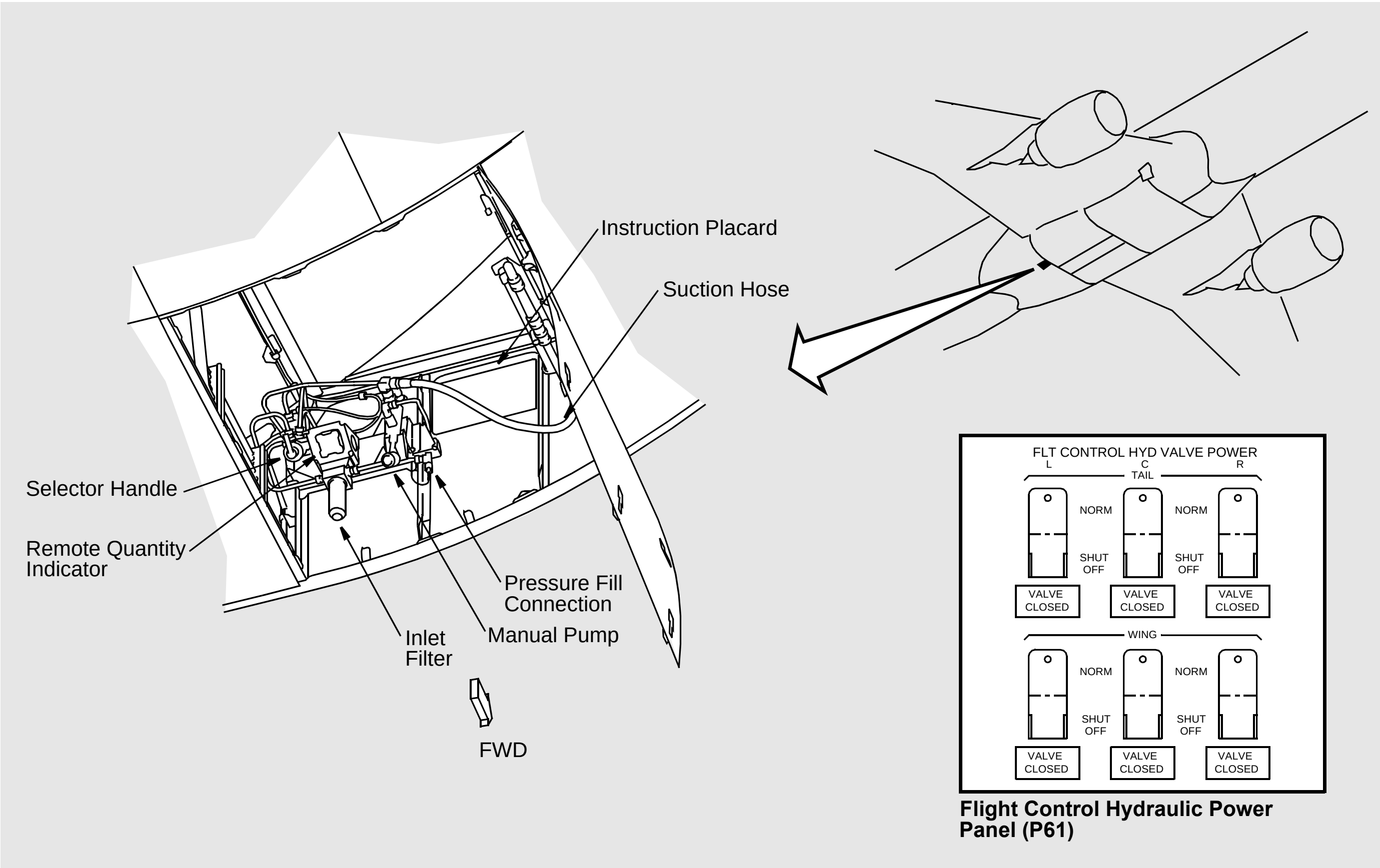
The ON position of the demand pump switches cancels the HYDIM demand pump control.

The HYDIM cards also control these hydraulic system indications:

- System pressure
- Pump pressure
- Pump temperature
- Reservoir quantity
- Reservoir temperature
- Reservoir pressure.

MAINTENANCE ACCESS TERMINAL

Maintenance personnel can use the maintenance access terminal (MAT) to do tests on the hydraulic systems.



Reservoir Servicing and Maintenance Power

Reservoir Servicing Station

A reservoir servicing station in the right aft body fairing lets maintenance personnel fill the three hydraulic system reservoirs.

A selector handle selects the reservoir to fill. The remote quantity indicator shows the fluid quantity in the reservoir selected.

To fill the selected hydraulic reservoir, maintenance personnel use either a ground cart that connects to the pressure fill connection, or the manual pump and suction hose.

Replacement hydraulic fluid goes through an inlet filter in the service station.

Maintenance Panel

The flight control hydraulic power panel is on the P61 overhead maintenance panel. Guarded switches control six hydraulic shutoff valves to the wing and tail flight controls. An amber light, below each switch, shows that its shutoff valve is not fully open. An EICAS message also shows.

Maintenance personnel use these switches to isolate hydraulic pressure for system checks.

- **Main Landing Gear**
- **Nose Landing Gear**
- **Landing Gear Controls and Indications**
- **Proximity Sensor System**
- **Air/Ground System**
- **Airplane Ground Steering**
- **Brakes**
- **Antiskid and Autobrake**
- **Brake Temperature Monitor System**
- **Tire Pressure Indication System**

Features

TRICYCLE LANDING GEAR

The tricycle landing gear has two main landing gear under the wings and one nose landing gear.

HYDRAULIC ACTUATION

The landing gear operates with center hydraulic system pressure. During normal operation, valves control the sequence of operation. An alternate gear extension system extends the landing gear without center hydraulic system pressure.

When the landing gear is fully retracted in flight, valves automatically remove hydraulic pressure from the landing gear.

ELECTRICAL CONTROL OF LANDING GEAR

The landing gear control lever has two positions and electrically controls the landing gear selector valves for landing gear operation.

PROXIMITY SENSOR SYSTEM

The proximity sensor system monitors the position of the proximity sensors and supplies signals to show the position of the landing gear and other aircraft systems.

AIR/GROUND SYSTEM

Load sensors monitor the weight of the aircraft on the landing gear and supply signals for air/ground detection. Many aircraft systems use these air/ground signals. Nose gear and main truck proximity sensors also supply air/ground signals for some limited functions.

SIX WHEELS ON THE MAIN TRUCKS

Each main landing gear truck has six wheels.

MAIN GEAR STEERING

The aft axles of the main gear trucks pivot to help the nose gear steer the airplane. This helps to decrease the turn radius and tire scrub.

CARBON BRAKES

All wheels of the main landing gear trucks have carbon brakes for reduced weight and longer life.

BRAKE SYSTEM CONTROL UNIT

A brake system control unit (BSCU) controls antiskid and autobrake operation and other brake system functions.

TAXI BRAKE RELEASE

During low taxi speed, the BSCU releases two brakes on each truck. This decreases brake and tire wear.

BRAKE INDICATIONS

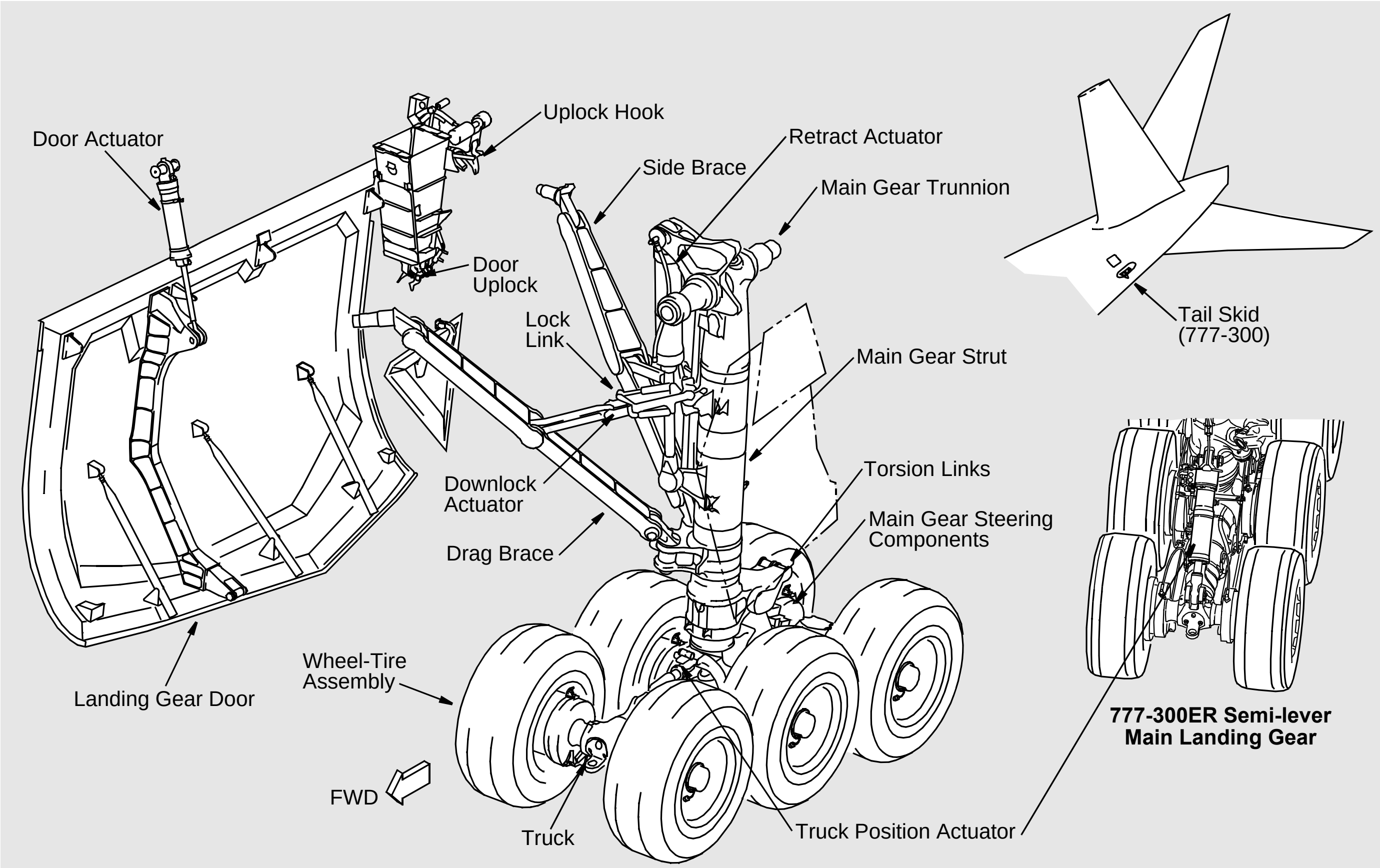
Lights on the nose gear show if the brakes and the parking brake are applied.

TAIL STRIKE INDICATION

A tail strike assembly (TSA) on the bottom of the aft part of the fuselage sends signals to the PSEUs if a tail strike occurs.

OTHER FEATURES

Other features include a brake temperature monitor system, a tire pressure indicating system, and an optional brake cooling system.



Main Landing Gear and Tail Skid

Main Landing Gear

The main landing gear strut includes an air-oil shock absorber. A drag brace and a side brace transmit loads from the strut to the airplane structure. Over-center mechanisms lock the two braces when the landing gear fully extends.

A landing gear door on each main gear wheel well opens and closes during gear retraction and extension.

Each truck has three axles. A brake and a wheel-tire assembly are at the end of each axle for a total of six wheels on each main landing gear. The aft axle turns for main gear steering.

The 777-300ER has a semi-lever gear for an increased takeoff lift and tail clearance. The truck position actuator locks during takeoff, and airplane rotation is around the rear axle.

NORMAL OPERATION

The main landing gear uses hydraulic pressure from the center system to retract and extend. Sequence valves control the door and gear movement.

Drag brace and side brace downlock actuators lock the gear in the extended position. Uplock hooks lock the landing gear in the retracted position.

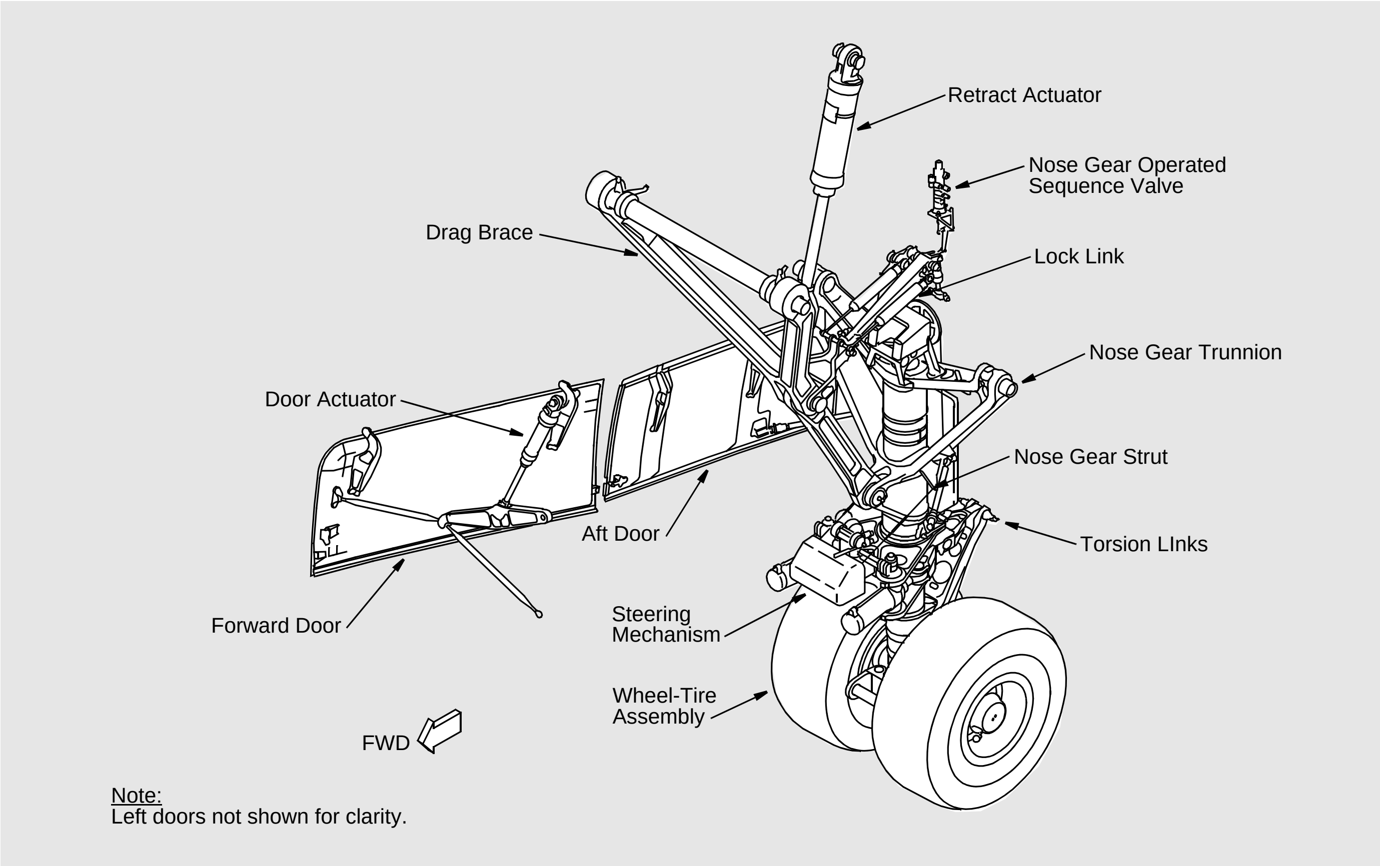
The main landing gear trucks do a tilt of approximately 13 degrees forward wheels up with the gear extended in flight. The gear trucks do a tilt of approximately 5 degrees forward wheels down when the gear is up and locked, or the gear is in transit.

ALTERNATE EXTENSION

The alternate extension system permits landing gear extension if the center hydraulic system has no pressure. An alternate extend power pack supplies hydraulic pressure to release the landing gear doors and the landing gear. The doors open, and the gear extends by their own weight. The gear doors stay open after an alternate extension.

GROUND DOOR OPERATION

The alternate extension system lets you open the doors when the airplane is on the ground. The doors open by their own weight. Center system hydraulic pressure closes the doors.



Nose Landing Gear

Nose Landing Gear

The nose landing gear strut includes an air-oil shock absorber. A drag brace transmits loads from the strut to the airplane structure. The drag brace folds. At full extension or retraction of the nose gear, the over-center mechanism of the lock link locks the drag brace.

The forward doors of the nose gear wheel well operate hydraulically during gear retraction and extension. The aft doors operate by mechanical linkages that connect to the nose gear. The aft doors close only when the gear retracts.

NORMAL OPERATION

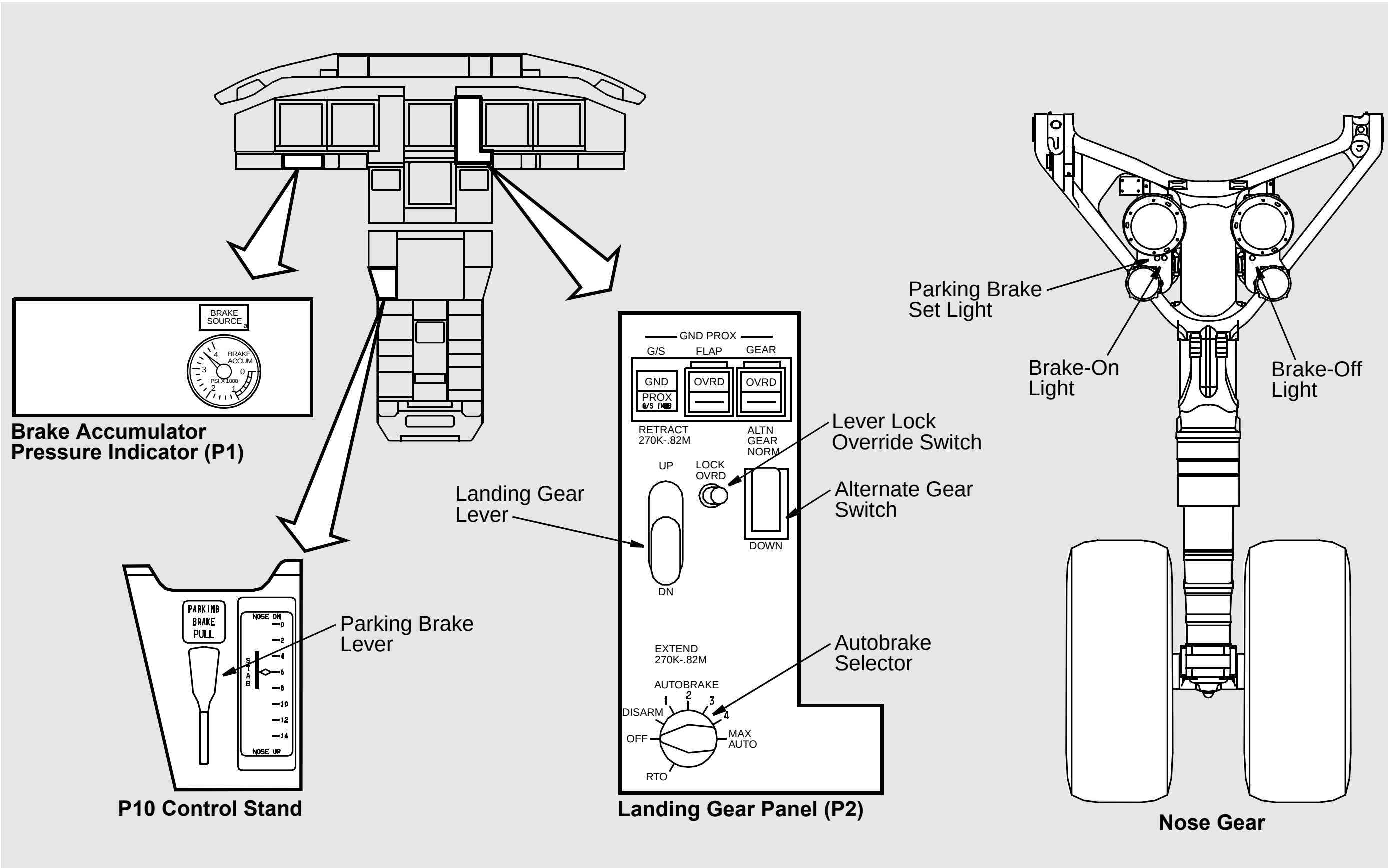
The nose landing gear uses center system hydraulic pressure to retract and extend. Sequence valves control forward door and landing gear movement.

ALTERNATE EXTENSION

Nose gear alternate extension uses hydraulic pressure from the alternate extend power pack. The forward doors open and the landing gear extends by its own weight. The forward doors stay open after an alternate extension.

GROUND DOOR OPERATION

The alternate extension system permits you to open the forward doors when the airplane is on the ground. The forward doors open by their own weight. The doors close with hydraulic pressure from the center system.



Landing Gear Controls and Indications

Landing Gear Controls and Indications

FLIGHT DECK CONTROLS

These landing gear controls are on the flight deck:

- Landing gear lever
- Alternate gear switch
- Autobrake selector
- Parking brake lever.

The landing gear lever has two positions, down (DN) and UP.The lever electrically controls the landing gear selector valves to control the hydraulic operation of the landing gear. An automatic lever lock prevents the lever from being moved up on the ground. A lever lock override switch permits the lever to be unlocked manually.

A guarded switch next to the lever lock override switch turns on the alternate extend power pack. This permits the gear to extend by gravity.

The autobrake selector is below the landing gear lever. This selector arms the autobrake system for landing autobrakes or for rejected takeoff (RTO).

You set the parking brakes with the parking brake lever on the P10 control stand.

LANDING GEAR INDICATION

The EICAS display shows the position of the landing gear. The DOWN indication shows continuously when the landing gear is down and locked. The UP indication goes out of view 10 seconds after the landing gear is up and locked. During an alternate landing gear extension or a non-normal condition, an expanded indication shows the position of each gear.

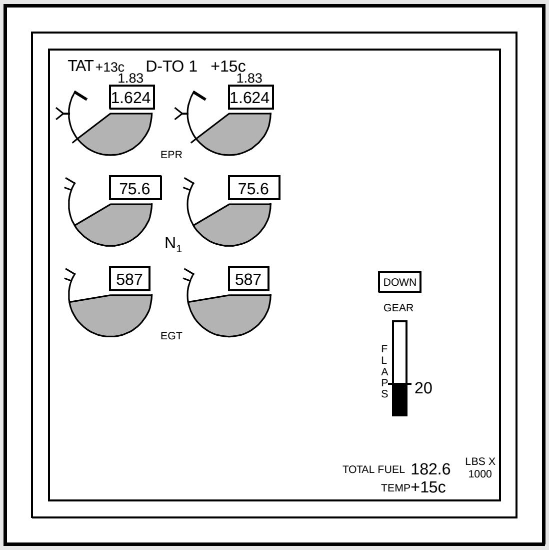
There are warning, caution, and advisory messages for the landing gear. The status, maintenance, and synoptic displays show additional landing gear information.

A brake accumulator gage shows brake accumulator pressure.

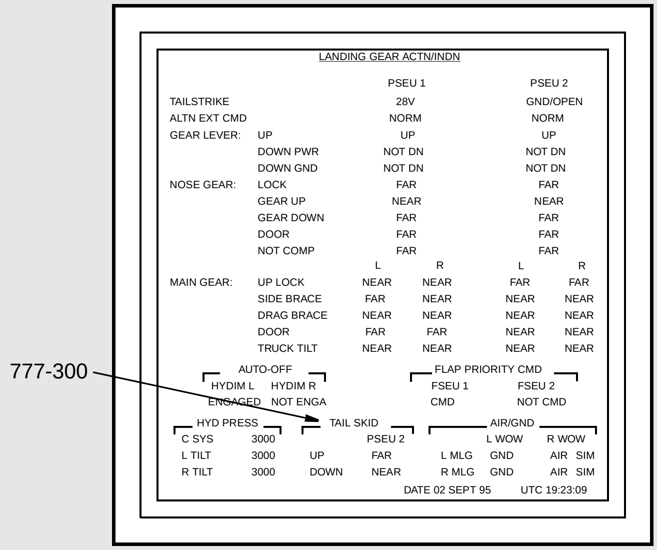
Brake status lights on the nose gear show the condition of the brakes.

DOOR GROUND CONTROL

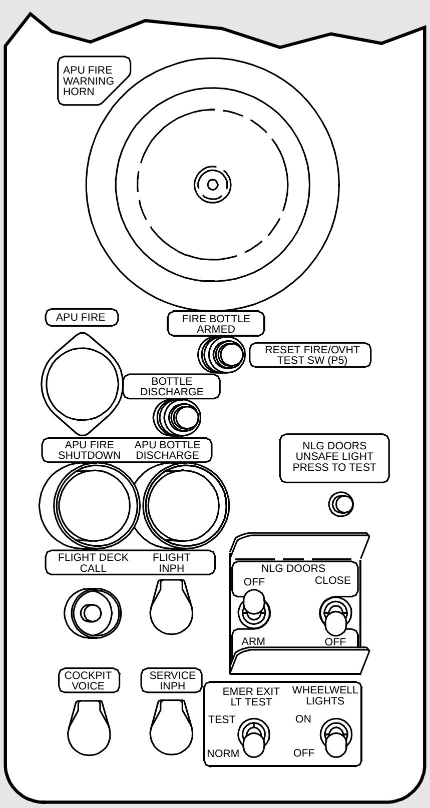
Two switches on the main wheel well electrical service panel open all the landing gear doors. These switches also close the main landing gear doors. Two switches on the service and APU shutdown panel close the nose gear doors.



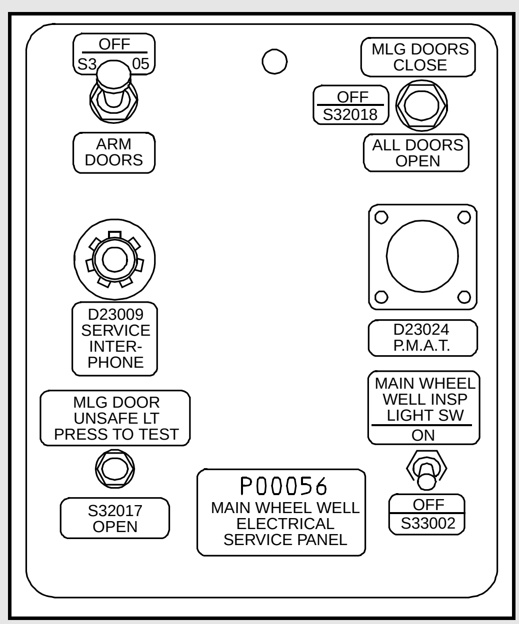
EICAS Display



Landing Gear Actuation/Indication Maintenance Page

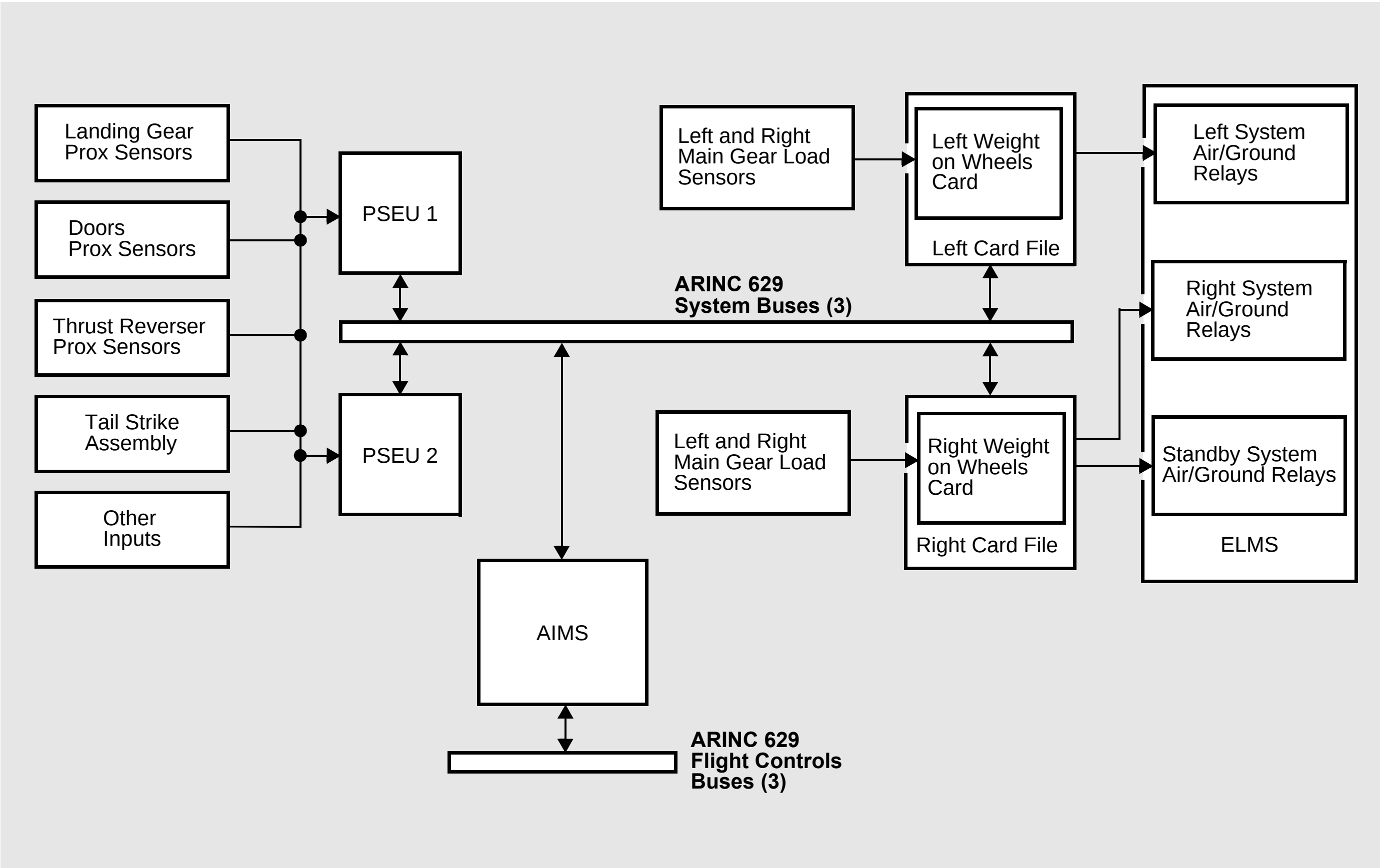


P40 Service and APU Shutdown Panel



P56 Main Wheel Well Electrical Service Panel

Landing Gear Controls and Indications



Proximity Sensor and Air/Ground System Block Diagram

Proximity Sensor System

The proximity sensor system (PSS) monitors the position of some airplane components.

The proximity sensor system has two proximity sensor electronic units (PSEUs) which get input from proximity sensors on these systems:

- Landing gear
- Landing gear doors
- Passenger entry, cargo and access doors
- Thrust reversers.

The PSEUs also get signals from the tail strike assembly (TSA) and other airplane systems.

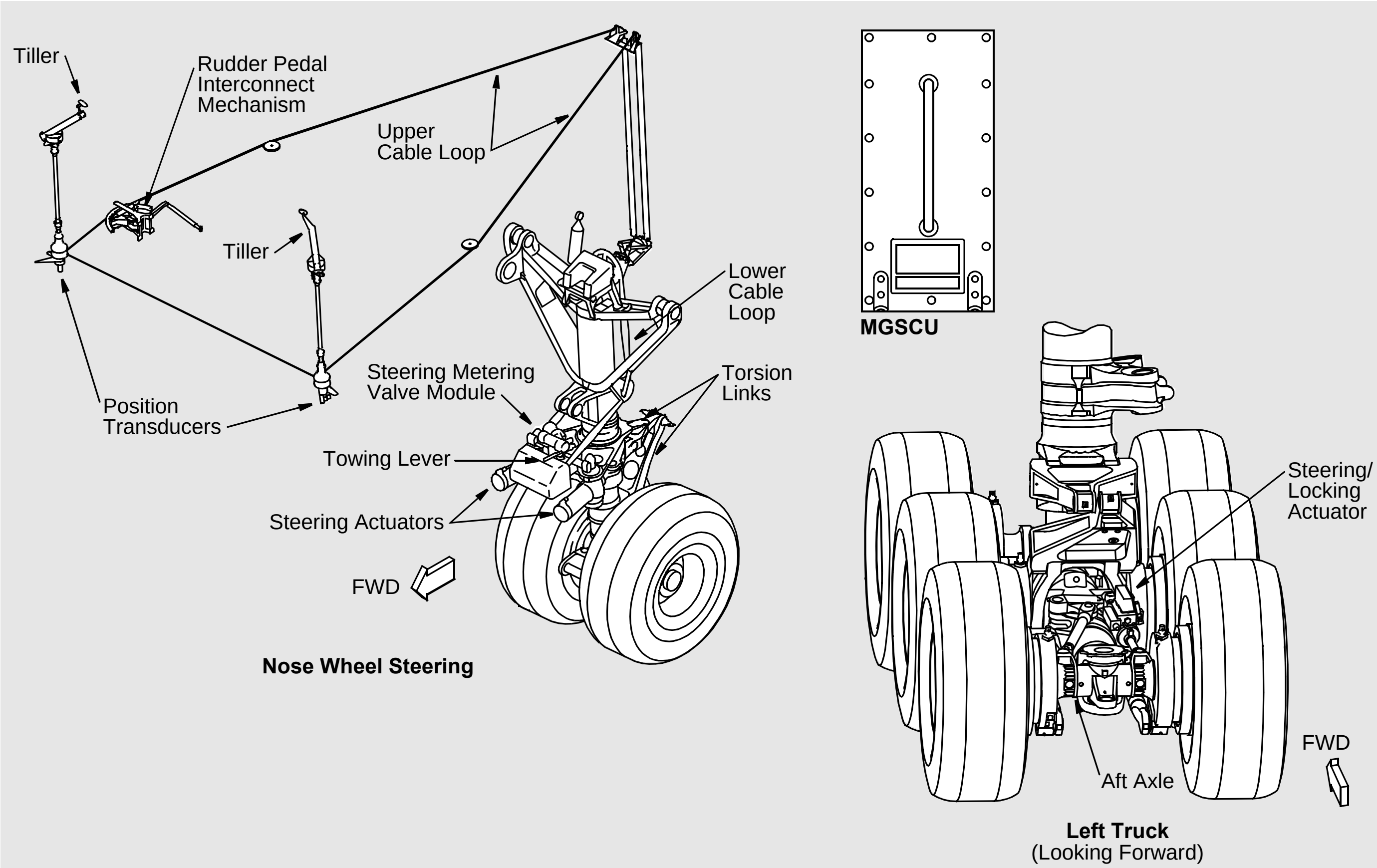
The tail strike assembly is on the bottom of the airplane in the tail strike area. The TSA has two electrical wires that go to the PSEUs. If a tail strike occurs, the wires will open or short. This tells the PSEUs that there has been a tail strike.

The PSEUs supply data to the AIMS through the ARINC 629 system buses. The PSEUs also supply signals for other airplane systems through hard wires.

Air/Ground System (AGS)

Two load sensors on each main landing gear support beam send airplane weight on wheels data to two weight on wheels (WOW) cards. The WOW cards supply signals to airplane systems and control air/ground relays in the ELMS. These air/ground relays control electrical circuits for many of the systems.

The WOW cards supply data to the AIMS for indication on EICAS and to the ARINC 629 flight control buses.



Nose Wheel and Main Gear Steering

Airplane Ground Steering

NOSE GEAR STEERING

Two tillers control the nose wheel movement to a maximum of 70 degrees in each direction. The rudder pedals control the nose wheel movement to a maximum of 7 degrees in each direction.

An upper cable loop gets inputs from the tillers or from the rudder pedals through the rudder pedal interconnect mechanism. The upper cable loop drives a lower cable loop.

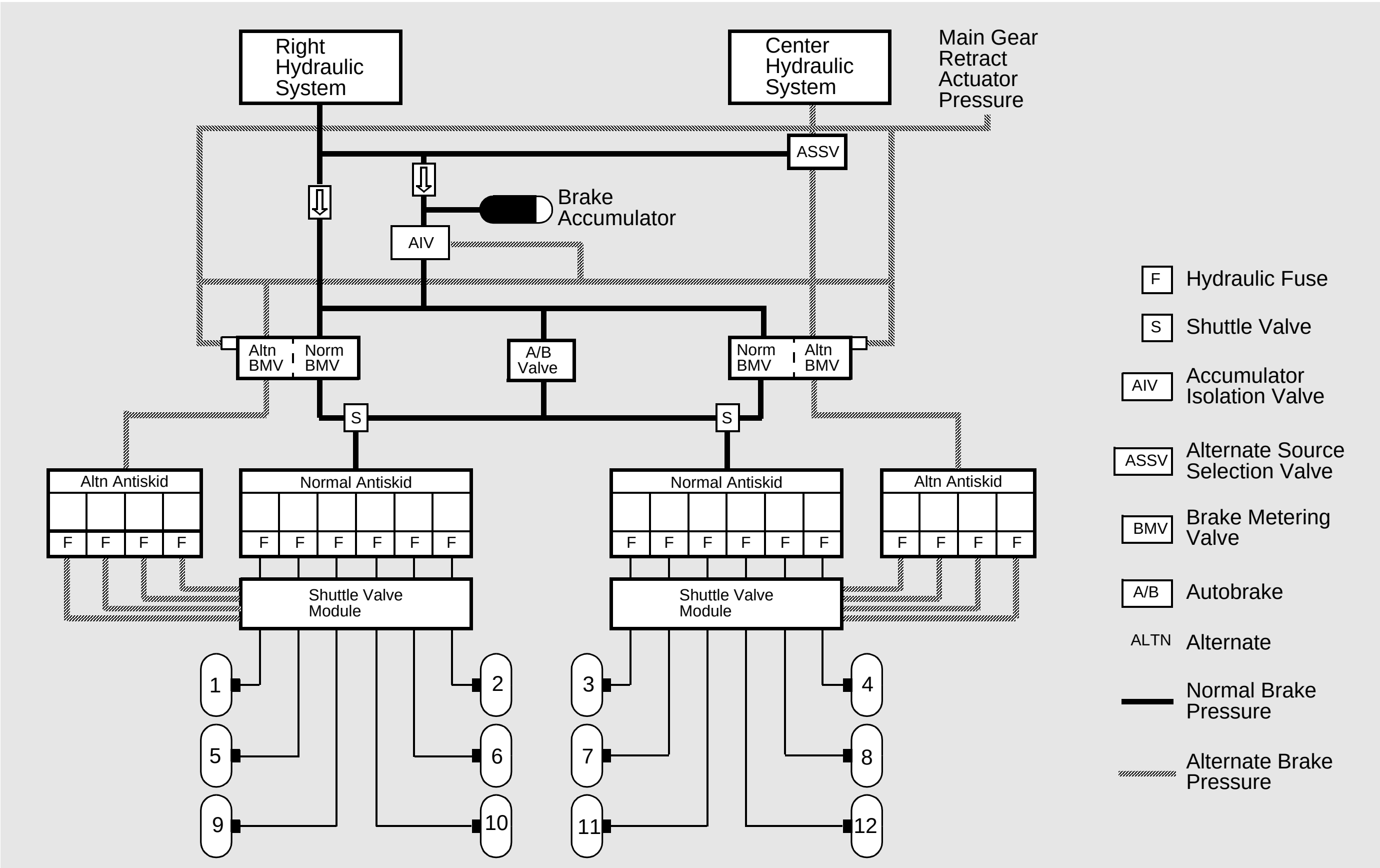
The lower cable loop supplies inputs to the steering metering valve module to supply center hydraulic pressure to the two actuators. The steering metering valve module has a dynamic load damper for shimmy protection. It also has a towing lever to depressurize the nose wheel steering during towing. A pin holds the towing lever in the tow position.

MAIN GEAR STEERING

Main gear steering operates when nose wheel steering commands are more than 13 degrees. The main gear steering control unit (MGSCU) receives tiller position and controls the aft axles to steer up to 8 degrees left or right. Main gear steering also uses center hydraulic system pressure.

When not steered, the steering/locking actuators align the aft wheels with the forward wheels of the main landing gear and lock the aft axles.

The MGSCU monitors the aft axle steering system for faults. Faults stop the operation of the main gear steering system and an EICAS message shows.



Brake System Diagram

Brakes

A multiple disc carbon brake is on each main landing gear wheel. There are no brakes on the nose wheels.

BRAKE SYSTEM

Two sets of brake pedals control the brakes. The pedals connect by cables to the left and right brake metering valves. The metering valves supply hydraulic pressure to the brakes in proportion to the pedal movement.

Normal braking uses right system hydraulic pressure and alternate braking uses center system hydraulic pressure. The accumulator isolation valve (AIV) and alternate source selection valve (ASSV) make an automatic selection of normal or alternate braking based on the hydraulic pressure source available. When there is no available hydraulic pressure for normal or alternate braking, a BRAKE SOURCE light and an EICAS message alert the flight crew. The brake accumulator then supplies brake pressure for about six full brake applications.

Separate brake metering valves, antiskid valves, and hydraulic fuses control the normal and alternate hydraulic pressure to the brakes. The normal and alternate brake lines connect at the shuttle valve modules.

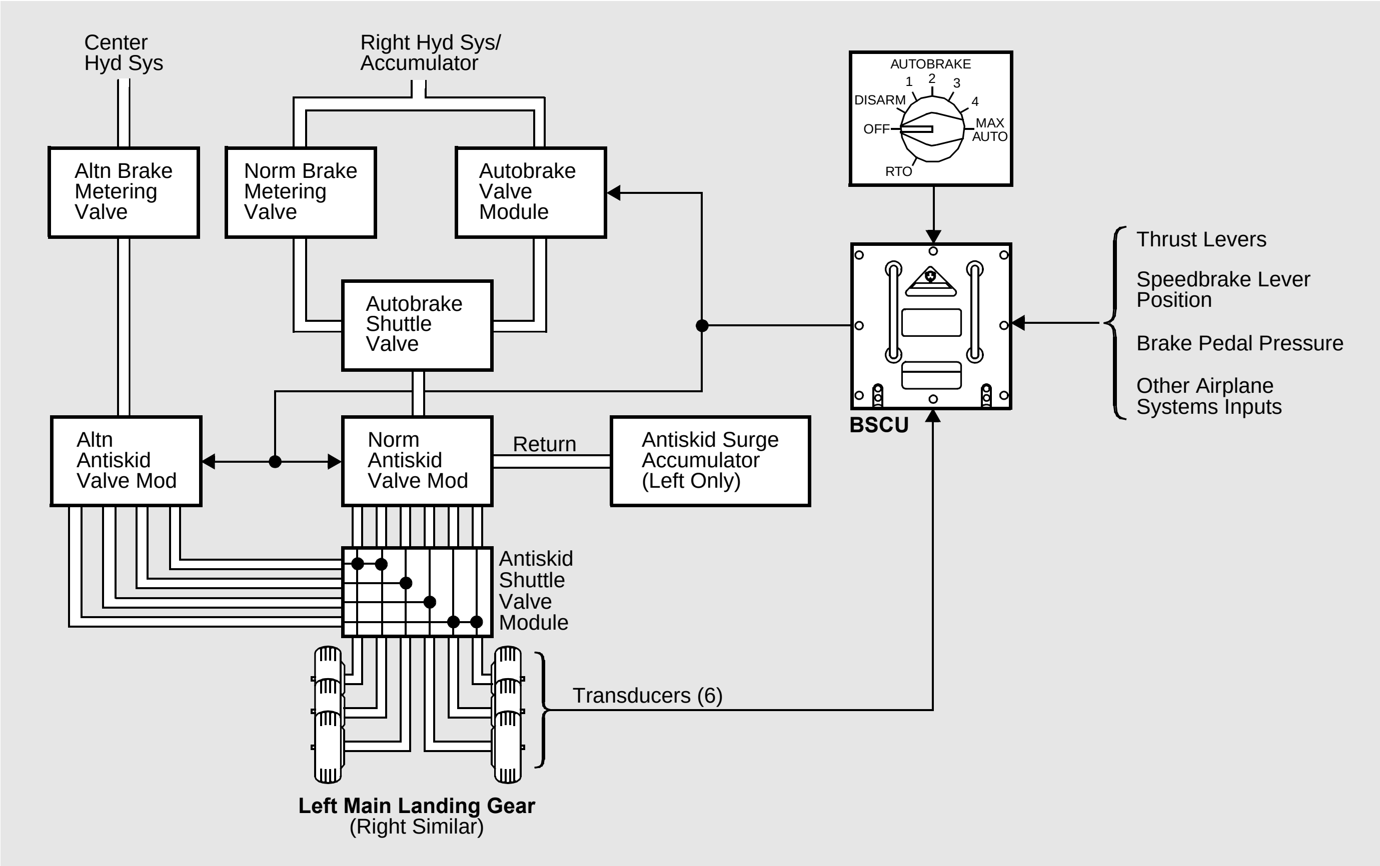
PARKING BRAKE

The brake accumulator in the right hydraulic system supplies brake pressure to the brakes when there is no hydraulic power on the airplane.

GEAR RETRACT BRAKING

During landing gear retraction, center system hydraulic pressure operates actuators on the alternate brake metering valves. The metered pressure stops wheel spin before the wheels enter the wheel wells.

The nose gear tires rub against spin brakes in the nose gear wheel well to stop wheel spin as they enter the nose wheel well.



Antiskid and Autobrake Diagram

Antiskid and Autobrake

The brake system control unit (BSCU) in the aft cargo compartment controls the antiskid and the autobrake systems.

ANTISKID

The primary function of the antiskid system is to control brake pressure to prevent tire skid.

The normal antiskid valve modules contain six antiskid valves. In normal braking, each valve controls hydraulic pressure to one brake. The alternate antiskid valve modules contain four valves. In alternate braking, each valve controls pressure to one or two brakes.

Each wheel has a wheel speed transducer which supplies signals to the BSCU. When a tire skids, the BSCU decreases the brake pressure to keep wheel skid to a minimum.

These are the BSCU secondary functions:

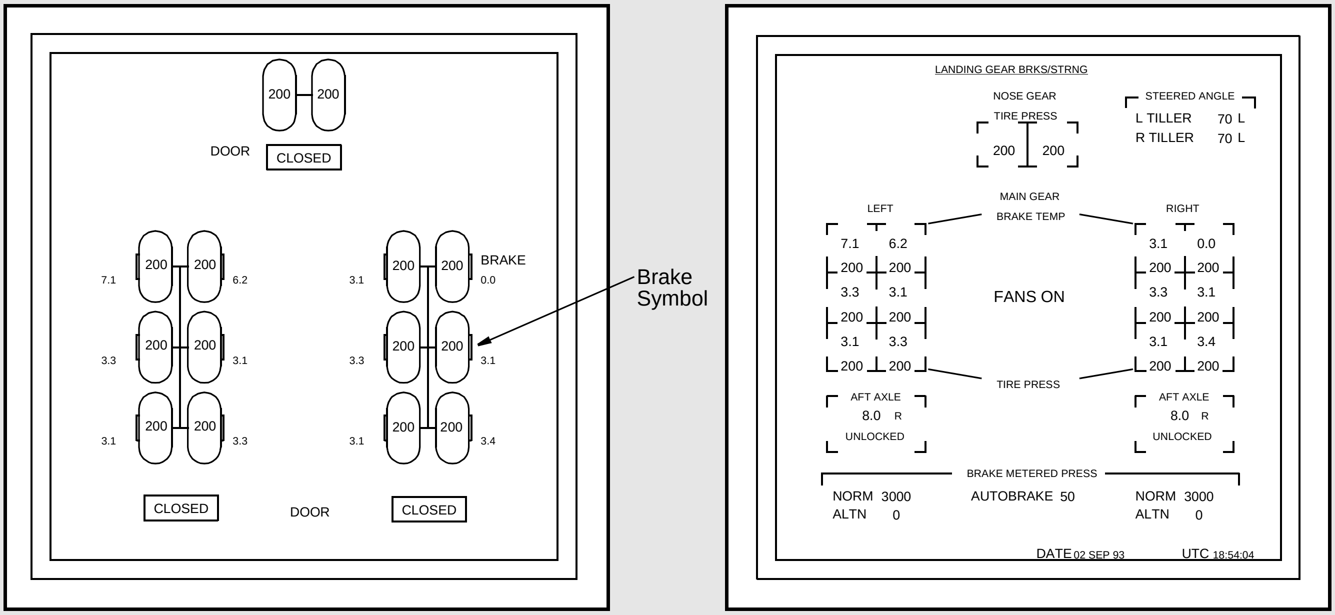
- Control brake pressure for locked wheel and hydroplane/touchdown protection
- Release, in sequence, one third of the brakes during low speed and low effort braking to reduce brake wear
- Make sure the antiskid system does not operate during gear retract braking.

AUTOBRAKE

Before landing, the pilot arms the autobrake and selects one of five deceleration rates with the autobrake selector. At touchdown with the thrust levers at idle, the BSCU controls the autobrake valve module to meter brake pressure for the selected deceleration rate. On the ground, the autobrake disarms with these pilot inputs.

- Thrust lever movement forward
- Speedbrake lever movement forward
- Brake pedal application.

The RTO function applies full hydraulic system pressure to the brakes if a takeoff is rejected.



Landing Gear Synoptic Display

Brake and Steering Maintenance Page

Brake Temperature and Tire Pressure Indications

Brake Temperature Monitor System

A thermocouple in each wheel brake measures the brake temperature and sends signals to the brake temperature monitor unit (BTMU). The BTMU shows the temperature for each brake on the landing gear synoptic display and the brake and steering maintenance page. A two digit number that goes from 0.0 (cold) to 9.9 (hot) shows temperature. A brake symbol next to the tire outline on the landing gear synoptic display changes color to show brake temperature conditions.

When a brake temperature is more than the value of 5.0, EICAS shows a BRAKE TEMP advisory message. The color of the number and the brake symbol on the synoptic display changes from white to amber to show this condition.

The BTMU contains BITE capabilities to find and show faults.

Tire Pressure Indication System

A tire pressure transducer, on each nose and main wheel, measures the tire pressure and sends signals to the tire pressure monitor unit (TPMU). The TPMU processes the signals and shows the tire pressure for each wheel on the landing gear synoptic display and the brake and steering maintenance page. Each tire pressure is in psi.

EICAS shows a TIRE PRESSURE advisory message when a tire pressure is not normal. The color of the number on the synoptic page changes to amber to show which tire pressure is non-normal.

The TPMU contains BITE to find and show faults.

Brake Cooling System

An optional brake cooling system operates automatically when the temperature of any of the brakes gets warm.

The system includes a brake cooling fan motor in each of the axles of the main landing gear wheels. The motor turns a fan impeller which causes air to flow around the main gear brake assemblies. The BTMU supplies a signal to start and stop the fan motors.

The brake and steering maintenance page shows a FANS ON indication when the system operates.

Features

FLIGHT CONTROL SYSTEMS

Two separate systems control the flight of the airplane, the primary flight control system (PFCS) and the high lift control system (HLCS).

PRIMARY FLIGHT CONTROL SYSTEM (PFCS)

The PFCS is an electronic fly-by-wire system. The PFCS supplies roll, pitch, and yaw control with these control surfaces:

- Ailerons
- Flaperons
- Spoilers
- Elevators
- Rudder
- Horizontal stabilizer.

HIGH LIFT CONTROL SYSTEM (HLCS)

The HLCS is an electronic fly-by-wire system. It has these control surfaces:

- Inboard and outboard trailing edge flaps
- Leading edge slats
- Krueger flaps.

ARINC 629 DIGITAL DATA BUSES

The PFCS and the HLCS use ARINC 629 digital data buses to communicate with other systems.

FLIGHT ENVELOPE PROTECTION

The PFCS has these flight envelope protection modes:

- Bank angle protection (BAP)
- Overyaw protection
- Overspeed protection
- Stall protection.

The pilots can always override the protection modes if necessary.

ADDITIONAL PFCS FUNCTIONS

Other functions of the PFCS are:

- Aileron lockout
- Aileron and flaperon droop
- Yaw damping
- Gust suppression
- Modal suppression
- Rudder ratio control
- Elevator off-load
- Flare compensation
- Backdrive actuator control
- Thrust asymmetry compensation.

HLCS PROTECTION FUNCTIONS

The HLCS has these protection functions:

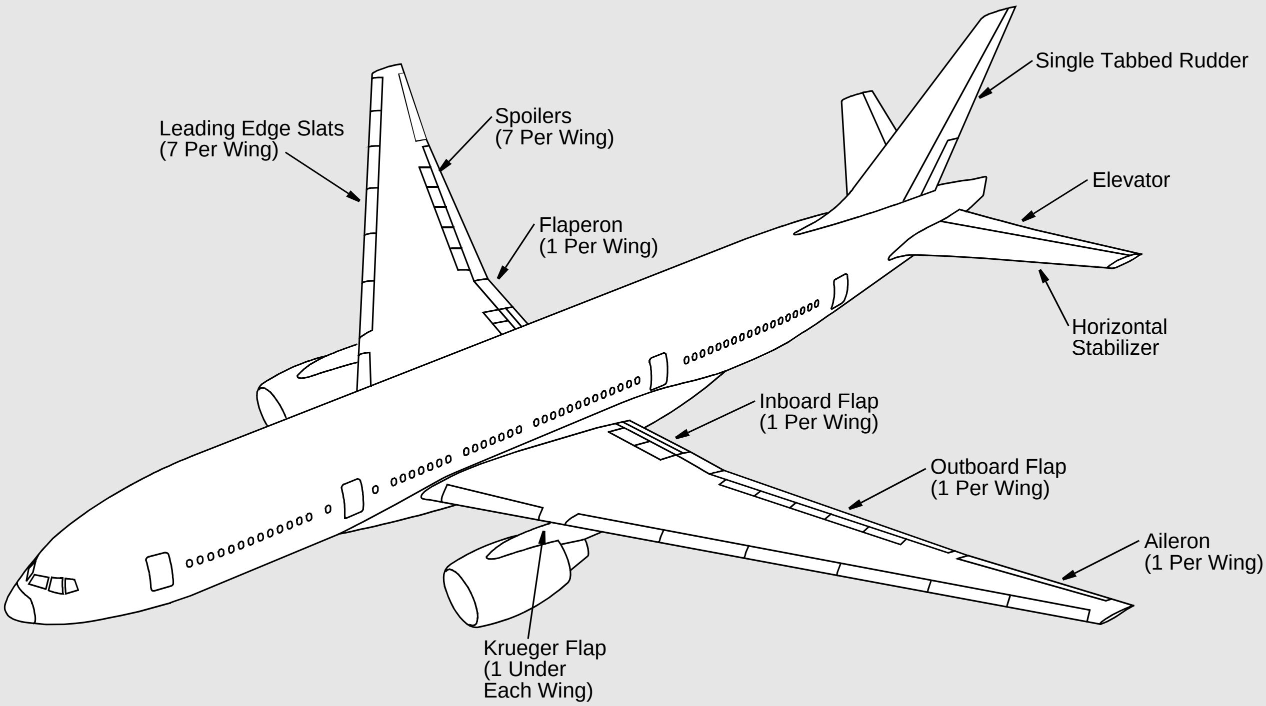
- Flap and slat load relief
- Autoslat extension
- Flap/slat sequencing
- Skew or asymmetry shutdown.

SHIELDING

Provisions, such as shielding, have been made to protect PFCS wiring from the effects of lightning and high intensity radiated fields (HIRF).

MECHANICAL CONTROL

Two spoilers and the horizontal stabilizer receive mechanical control signals from the pilots.



Flight Control Systems

Flight Control Systems

PRIMARY FLIGHT CONTROL SYSTEM

The primary flight control system (PFCS) is a modern, three-axis, fly-by-wire system. The fly-by-wire design permits a more efficient structural design. Some benefits of this design are increased fuel economy, and smaller vertical fin and horizontal stabilizer. This technology lets the airplane meet strict safety requirements with decreased weight and supplies improved control and protection.

The PFCS supplies manual and automatic airplane control and envelope protection in all three axes. There is stability augmentation in the roll, pitch. and yaw axes.

The PFCS calculates commands to move the control surfaces with sensor inputs from these components:

- Control wheels
- Control column
- Rudder pedals
- Speedbrake lever
- Pitch trim switches.

These are the control surfaces for roll control:

- Two ailerons
- Two flaperons
- Fourteen spoilers.

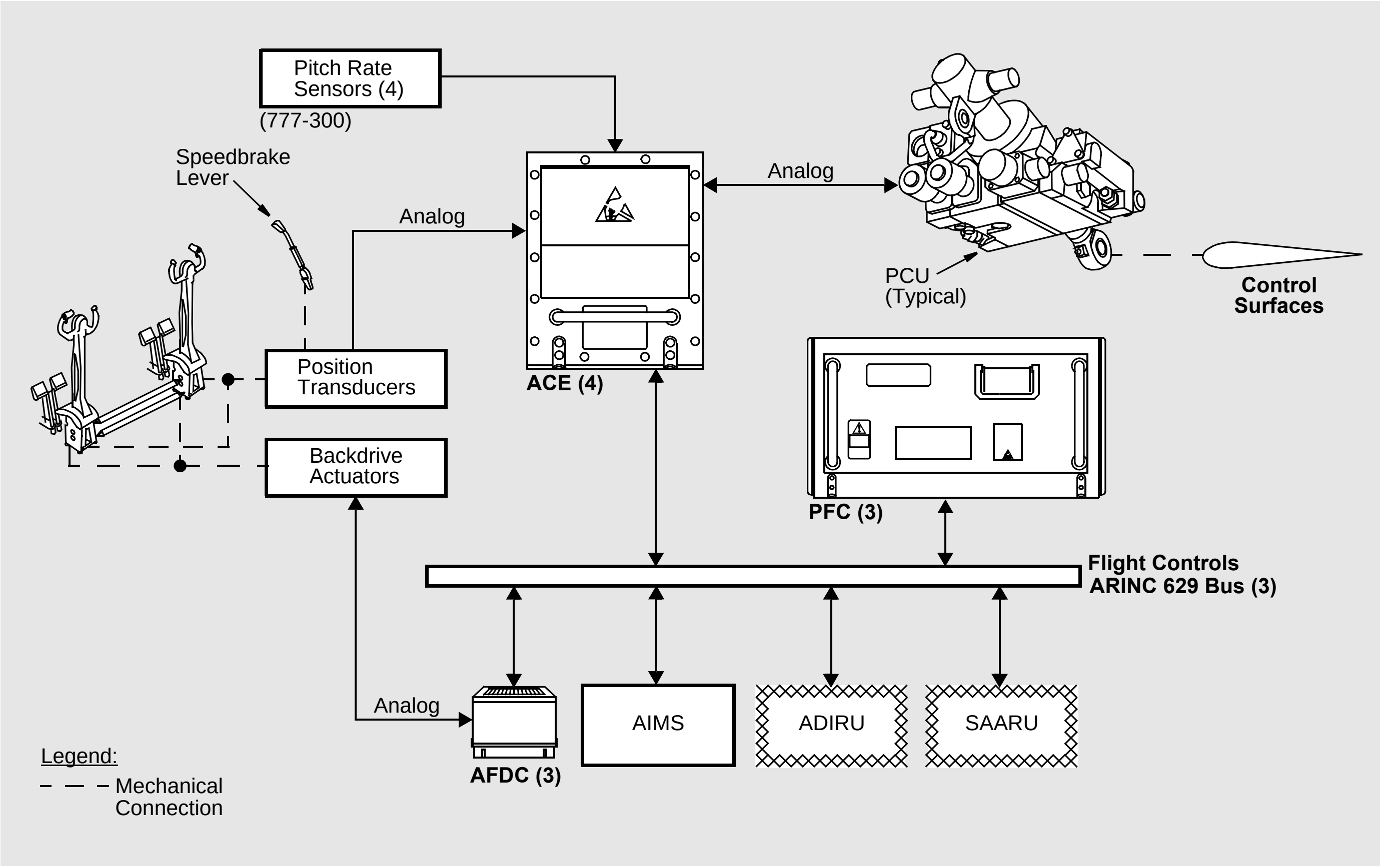
For pitch control, there are two elevators and a moveable horizontal stabilizer.

There is a tabbed rudder for yaw control.

HIGH LIFT CONTROL SYSTEM

The high lift control system (HLCS) supplies increased lift at lower speeds for takeoff and landing.

High lift surfaces include one inboard and one outboard trailing edge flap on each wing. There are seven leading edge slats and one Krueger flap on each wing.



PFCS Operational Overview

PFCS Operational Overview

MANUAL OPERATION

Position transducers change the flight crew commands of the control wheels, the control columns, the rudder pedals, and the speedbrake lever to analog electrical signals. These signals go to the actuator control electronics (ACEs). The ACEs change the signals to digital format and send them to the primary flight computers (PFCs).

The PFCs communicate with the airplane systems through the three flight controls ARINC 629 buses. The PFCs use mid-value selection on the input command signals. In addition to command signals from the ACEs, the PFCs also receive data from the AIMS, ADIRU and SAARU. These signals are airspeed, attitude and inertial reference data. The PFCs calculate the flight control commands based on control laws, augmentation and envelope protections. The digital command signals from the PFCs go to the ACEs.

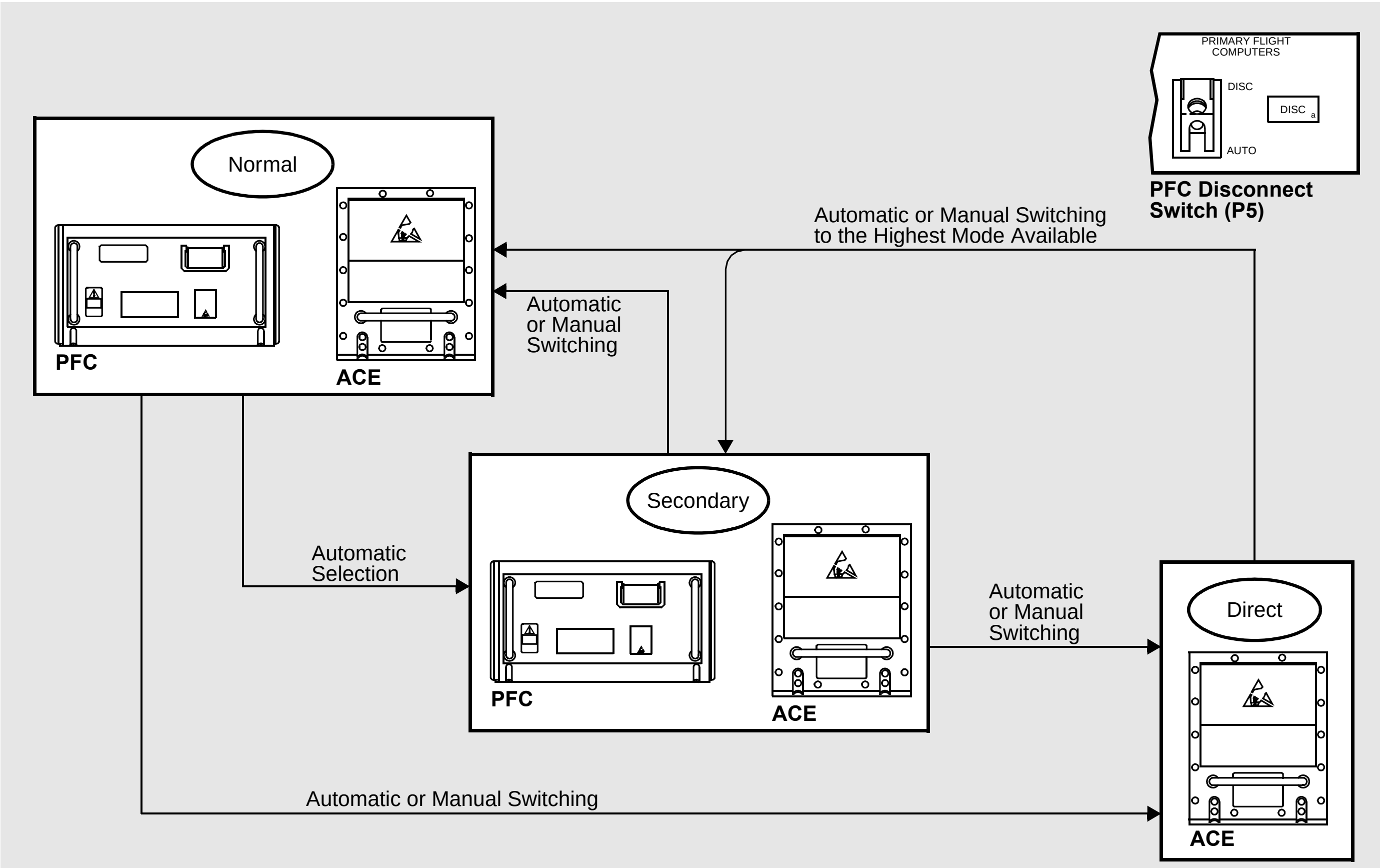
The ACEs change these command signals to analog format and send them to the power control units (PCUs). One, two or three PCUs operate each control surface. The PCUs contain a hydraulic actuator, an electro-hydraulic servo-valve, and position feedback transducers.

The servo-valve causes the hydraulic actuator to move the control surface. The actuator position transducer sends a position feedback signal to the ACEs. After conversion to digital format, the ACEs send the signal to the PFCs. The ACEs stop the PCU command when the position feedback signal equals the commanded position.

Some of the PCUs have differential pressure transducers to measure the force from the PCU. The PFC uses this pressure data to equalize the force of all PCUs of a control surface.

AUTOPILOT OPERATION

The PFCs receive autopilot commands from the three autopilot flight director computers (AFDCs). The PFCs calculate the flight control commands in the same manner as for manual operation. In addition, the PFCs supply the backdrive signals to the backdrive actuators through the AFDCs. The backdrive actuators move the control wheels, control columns and rudder pedals in synchronization with the autopilot commands. The movement of the flight deck controls supplies visual feedback of autopilot control to the flight crews.



PFCS Operational Modes

PFCS Operational Modes

The PFCS has three modes of operation:

- Normal
- Secondary
- Direct.

NORMAL MODE

All control laws and protection functions are active in the normal mode.The control laws calculate commands for roll, yaw, and pitch control. The protection functions include stall warning, overspeed, overyaw, and bank angle.

The autopilot operates only in the normal mode. It cannot be engaged in the secondary or direct mode.

SECONDARY MODE

The PFCS changes to the secondary mode if the PFCS finds a loss of important sensor data.

The secondary mode operates the same as the normal mode except that the protection functions and the autopilot are not available.

DIRECT MODE

The PFCS changes to the direct mode if sensor data degrades further or if there are failures that make the normal and secondary modes unreliable.

In the direct mode, position transducer signals (pilot commands) go directly to the ACEs and to the PCUs. The PFCs do not operate in this mode.

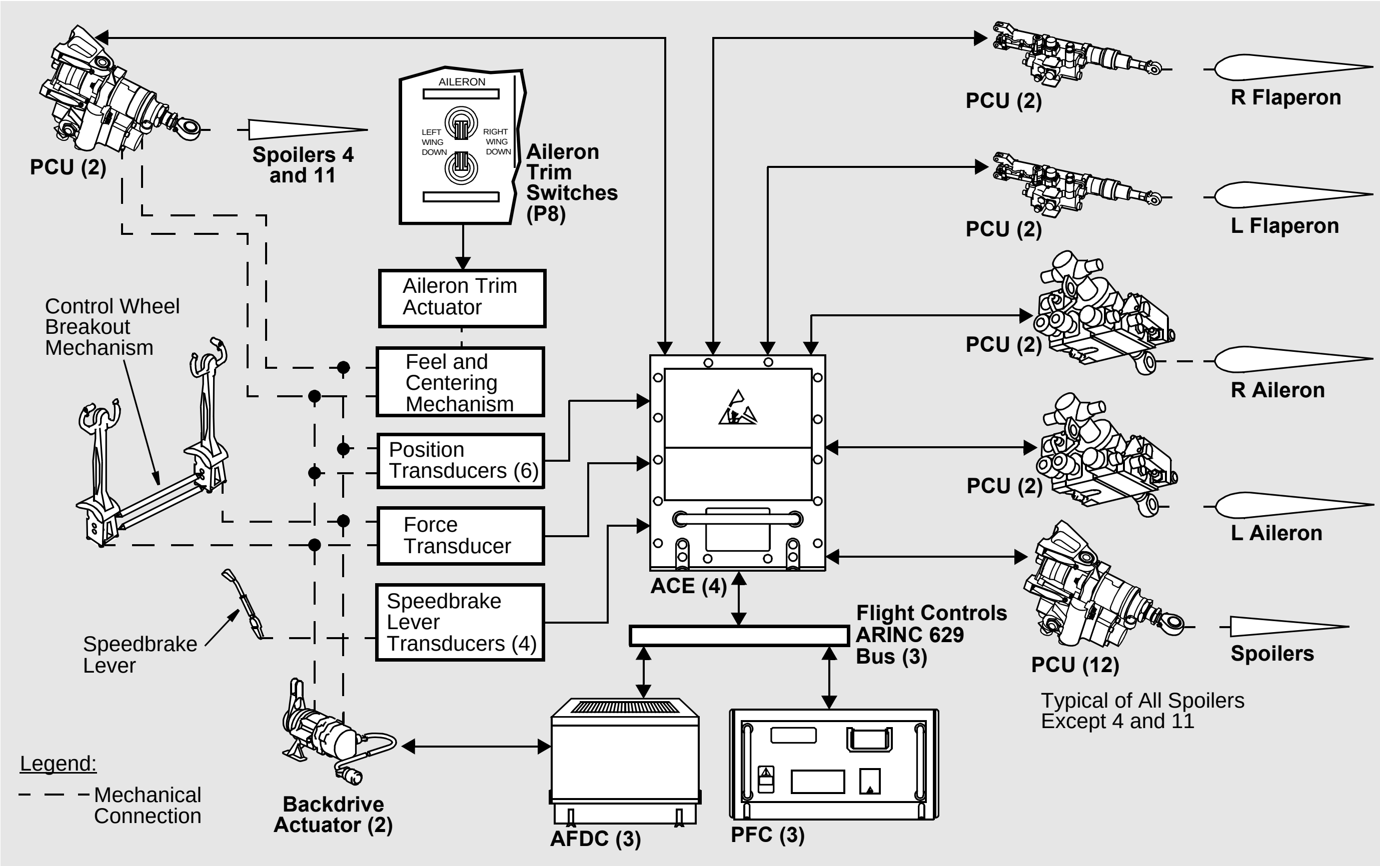
The PFCS protection functions and the autopilot are not available in the direct mode.

FLIGHT DECK CONTROLS

The PFC disconnect switch, on the P5 overhead panel, has two positions: AUTO and DISC. In the AUTO position, the PFCS mode selection is automatic. When the switch is in the DISC position, the PFCS changes to the direct mode.

The PFC disconnect switch permits the pilots to select the direct mode of operation. If the switch is cycled or moved again to AUTO, the PFCS goes from the direct mode to the highest mode available.

An amber light adjacent to the switch shows when the PFCS is in the direct mode.



PFCS Roll Control

Roll Control

The ailerons, the flaperons, and the spoilers control the roll attitude of the airplane. The spoilers also function as speedbrakes.

FLIGHT DECK CONTROLS

A cable system connects the two control wheels through a breakout mechanism. A mechanical feel and centering mechanism supplies feel forces to the control wheels.

Each control wheel moves three independent position transducers. The position transducer signals go to the ACEs and then to the PFCs. There is a force transducer to detect a pilot override of the bank angle protection.

Two trim switches supply power to the aileron trim actuator to move the control wheels. A decal, on the top of the control wheel, shows the position of the aileron trim.

CONTROL SURFACES

The ailerons move a maximum of 33 degrees up and 19 degrees down. Counterweights balance the ailerons. The flaperons move a maximum of 11 degrees up and 34 degrees down. Two PCUs operate each aileron and flaperon.

The inboard and outboard spoilers move a maximum of 60 degrees up except for spoilers 4 and 11, which move a maximum of 45 degrees. One PCU operates each spoiler.

AILERON AND FLAPERON DROOP

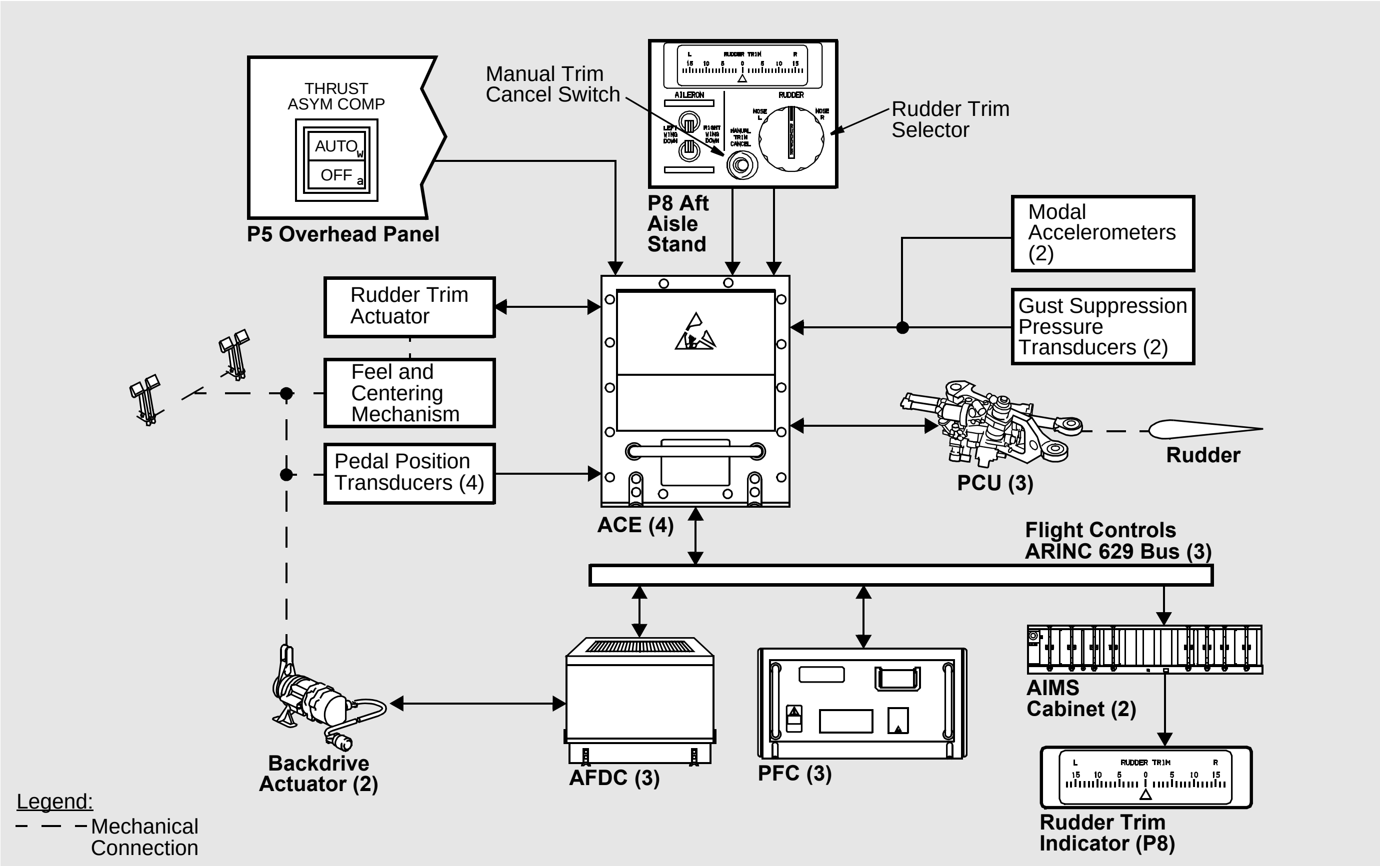
When the flaps extend, the ailerons and flaperons move down (droop) to increase lift. When drooped, the ailerons and flaperons continue to supply roll control.

AILERON LOCKOUT

During high speed flight, the PFCs fair the ailerons to the wing and lock out their operation. At low speed, the PFCs unlock the ailerons and command their operation.

SPEEDBRAKE

The speedbrake lever, on the control stand, moves a multiple channel speedbrake transducer. The speedbrake transducer signals go to the ACEs and then to the PFCs. In flight, the PFCs command the speedbrakes to extend as a function of the speedbrake lever movement. At high speed, the PFCs prevent the operation of some spoilers. When the airplane lands, the auto speedbrake actuator automatically moves the speedbrake lever to cause the spoilers to deploy. Some spoilers are delayed until the pitch attitude is less than 2 degrees.



PFCS Yaw Control

Yaw Control

The rudder controls the yaw attitude of the airplane.

FLIGHT DECK CONTROLS

Linkages connect the two pairs of rudder pedals. A feel and centering mechanism supplies feel forces to the rudder pedals. The pedals move two independent position transducers that send their signals to the ACEs and the PFCs.

A crank, in front of each pilot, permits the adjustment of the pedals.

A rudder trim selector, on the aisle stand, supplies trim signals to the ACEs. The rudder trim actuator moves the rudder pedals when commanded by the ACEs. Two rudder trim rates are available. A rudder trim indicator, also on the aisle stand, shows the rudder trim position.

A manual trim cancel switch, on the aisle stand, sends a signal to the ACEs to command the trim to zero.

A switch on the P5 overhead panel permits the pilots to disable the thrust asymmetry compensation function.

CONTROL SURFACE

The rudder moves a maximum of 27 degrees in either direction. Three PCUs, which get power from different hydraulic power sources, operate the rudder. The rudder PCUs have a pressure valve to increase the PCU pressure when another PCU is not operating.

A rudder tab hinges on the rudder. The tab moves mechanically with the rudder to increase its effect.

RUDDER RATIO

The PFCs calculate the rudder ratio based on airspeed. The rudder ratio gradually reduces the maximum movement of the rudder as the airspeed increases.

YAW DAMPING

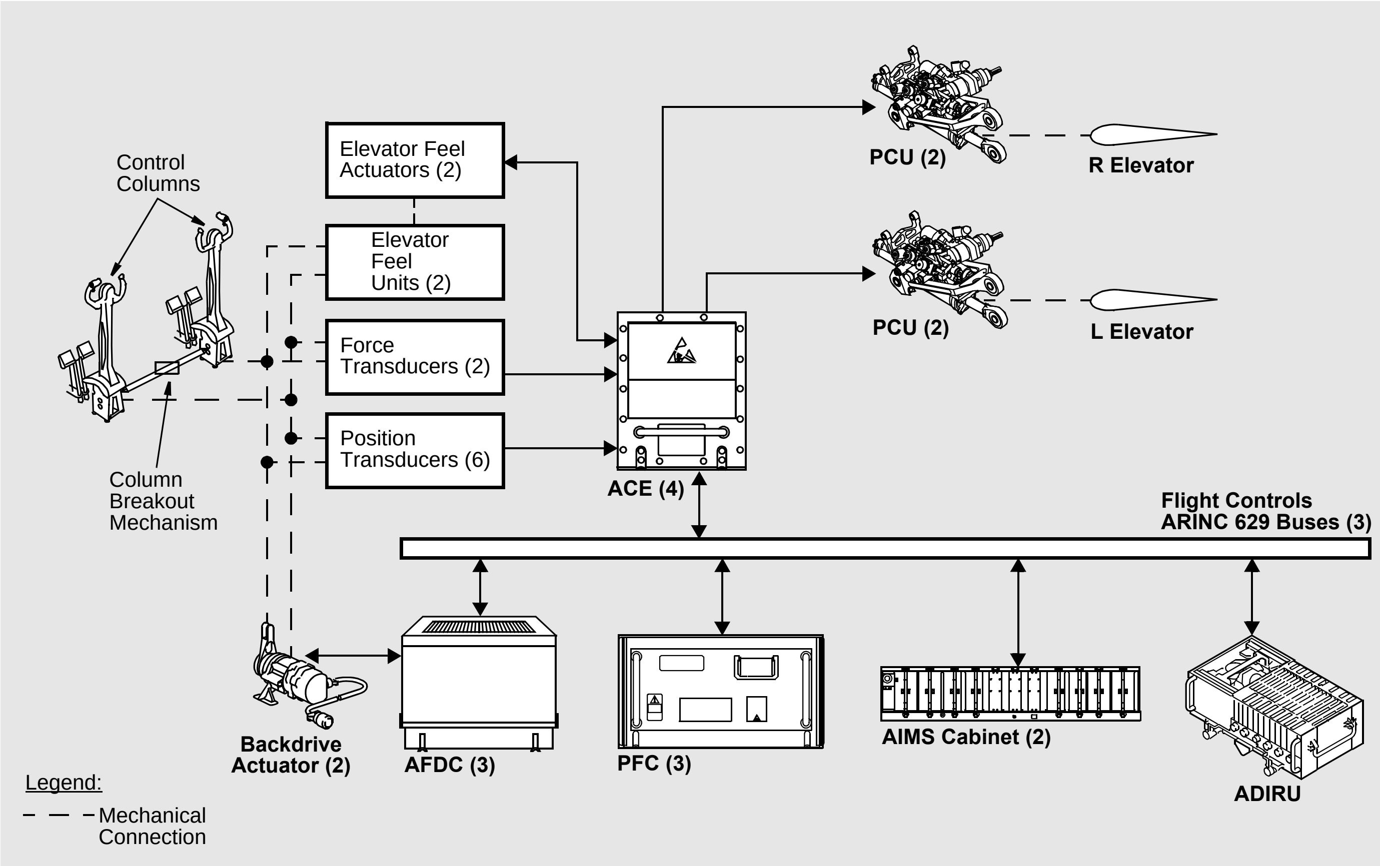
In flight, the PFCs send commands to move the rudder for Dutch roll damping and turn coordination.

GUST AND MODAL SUPPRESSION

The gust and modal suppression functions increase passenger comfort. The PFCs adjust the rudder position to dampen the effects of side gusts and other causes of lateral motion of the vertical fin.

THRUST ASYMMETRY COMPENSATION (TAC)

The TAC function helps the pilots during asymmetrical engine thrust. The PFCs send commands to the ACEs to move the rudder.



PFCS Pitch Control - Elevator

Pitch Control - Elevator

The elevators supply short-term correction of the pitch attitude of the airplane.

FLIGHT DECK CONTROLS

The torque tubes of the two control columns connect with a breakout mechanism. Each control column moves three independent position transducers. The position transducer signals go to the ACEs and then to the PFCs.

The force transducers measure the force that the pilot applies to the columns. When the force transducer signal is zero, the PFC uses a zero input position command.

Two elevator feel units, one forward of each torque tube, supply limited feel and center the columns. Two electric actuators, commanded by the PFCs through the ACEs, increase the feel forces supplied by each feel unit. The PFCs command the feel forces as a function of airspeed.

CONTROL SURFACES

The elevators hinge on the rear spar of the horizontal stabilizer. The elevators move a maximum of 33 degrees up and 27 degrees down. Two PCUs, which get power from different hydraulic power sources, operate each elevator.

The elevator PCUs have a pressure reducing valve operated by a solenoid and controlled by an ACE. When a PCU is not operating, the ACEs increase the pressure on the other PCU to maintain elevator movement.

STALL PROTECTION

When the airplane approaches a stall condition, the PFC causes the elevator to move for airplane pitch down.

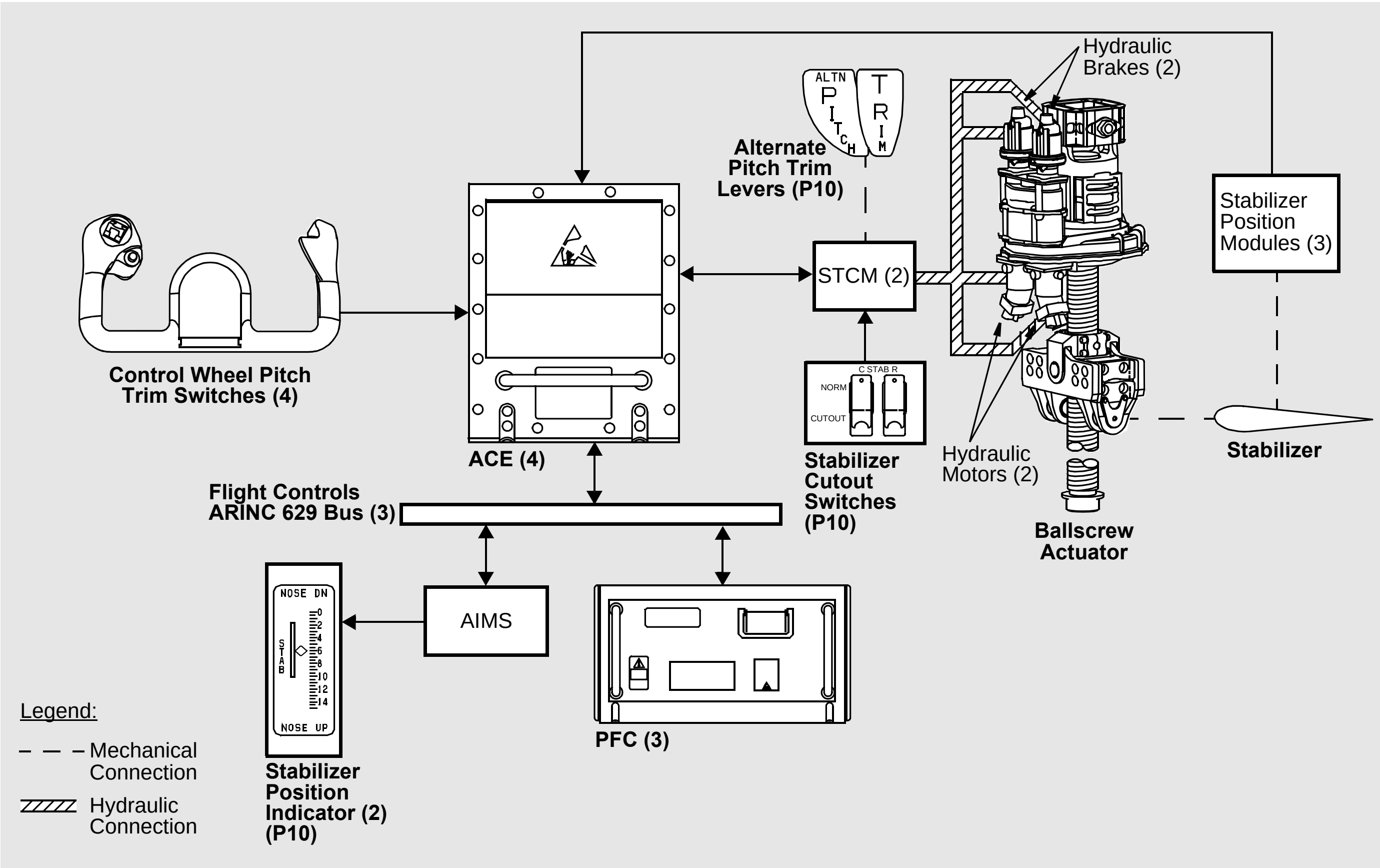
OVERSPEED PROTECTION

During an overspeed condition, the PFC causes the elevator to move for airplane pitch up.

SPEED STABILITY AND FLARE COMPENSATION

The PFC commands the elevator in pitch up or pitch down based on airspeed changes for speed stability.

During flare, the PFC commands a pitch down to simulate the natural attitude of the airplane in ground effect.



PFCS Pitch Control - Stabilizer

Pitch Control - Stabilizer

The horizontal stabilizer supplies long-term correction of the pitch attitude of the airplane.

FLIGHT DECK CONTROLS

The pilots use two pitch trim switches for manual pitch trim control. The switches, on the outboard of each control wheel, send electrical pitch trim signals to the ACEs. The pilots also use two alternate pitch trim levers on the left of the control stand.

Two guarded cut-out switches, on the control stand, control hydraulic shutoff valves to stop hydraulic pressure to the stabilizer.

Two stabilizer position indicators, on the control stand, show the position of the stabilizer. A green band on the indicator shows the range of correct stabilizer position for takeoff.

CONTROL SURFACE

The horizontal stabilizer is a one piece airfoil. It pivots at its rear spar. A ballscrew actuator, attached to the front spar, moves the stabilizer leading edge to a maximum of 4 degrees up and 11 degrees down.

Two hydraulic motors, which get power from different hydraulic power sources, cause the ballscrew actuator to rotate. Two hydraulic brakes prevent the ballscrew actuator from moving. Two stabilizer trim control modules (STCMs) receive commands from the ACEs to control the hydraulic pressure to the motors and brakes. A shutoff valve, on each STCM, stops hydraulic power when the applicable cutout switch is in the CUTOUT position.

Cables transmit the stabilizer movement to three stabilizer position modules (SPMs) in the stabilizer compartment. The SPMs supply stabilizer position data to the ACEs.

ELEVATOR OFFLOAD

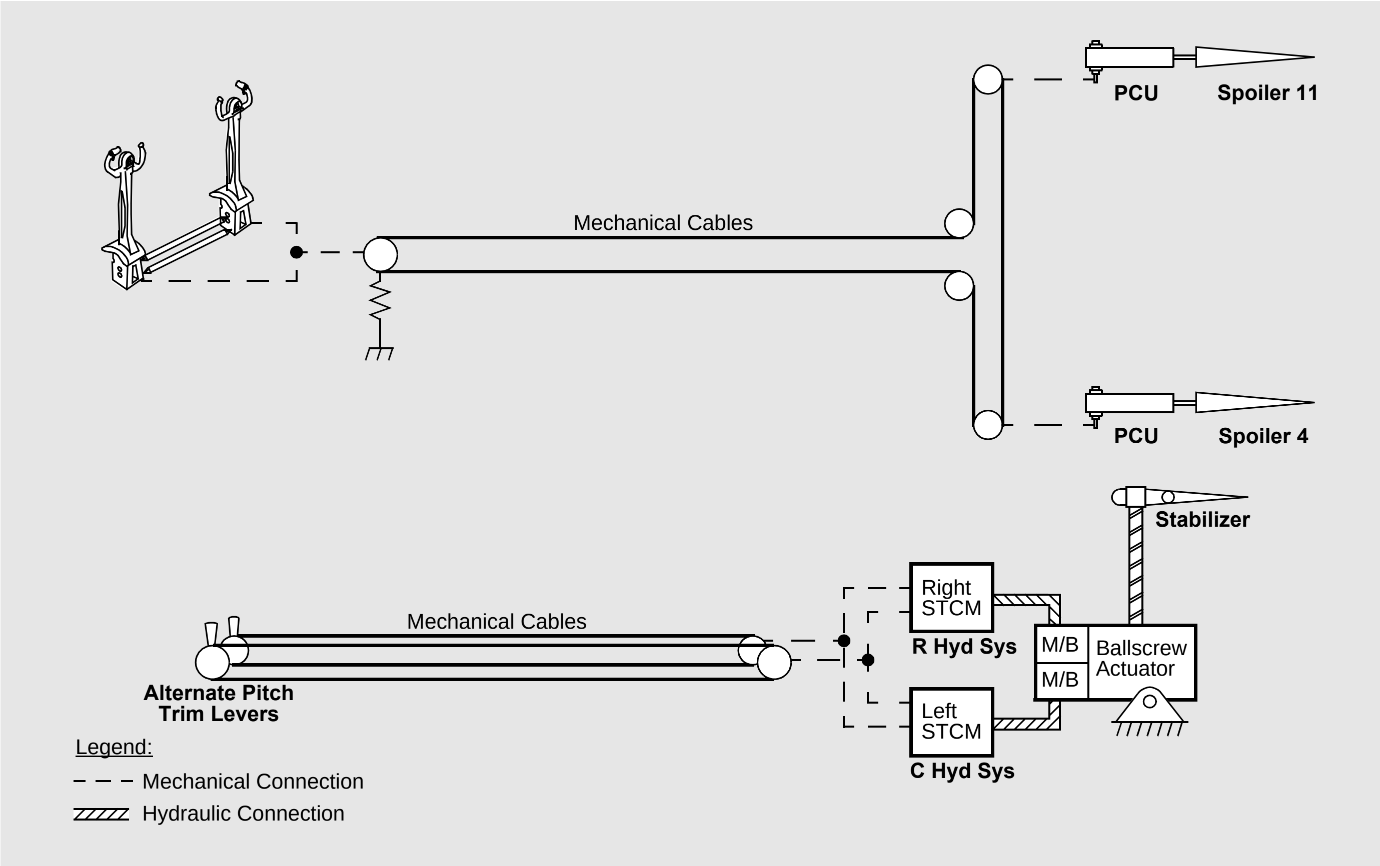
In the normal mode of operation, the PFCs command pitch trim when the elevator is not faired to the stabilizer for more than a set time.

COLUMN CUTOUT

When the pilot moves the control column in the opposite direction of the pitch trim direction, the PFCs cut out the pitch command to the STCMs. This stops the stabilizer ballscrew.

STABILIZER AUTO SHUTDOWN

If there is an uncommanded pitch trim, the PFCs command the STCM hydraulic shutoff valves to close.



PFCS Mechanical Control

PFCS Mechanical Control

A cable-driven system controls two spoilers and the stabilizer.

SPOILERS

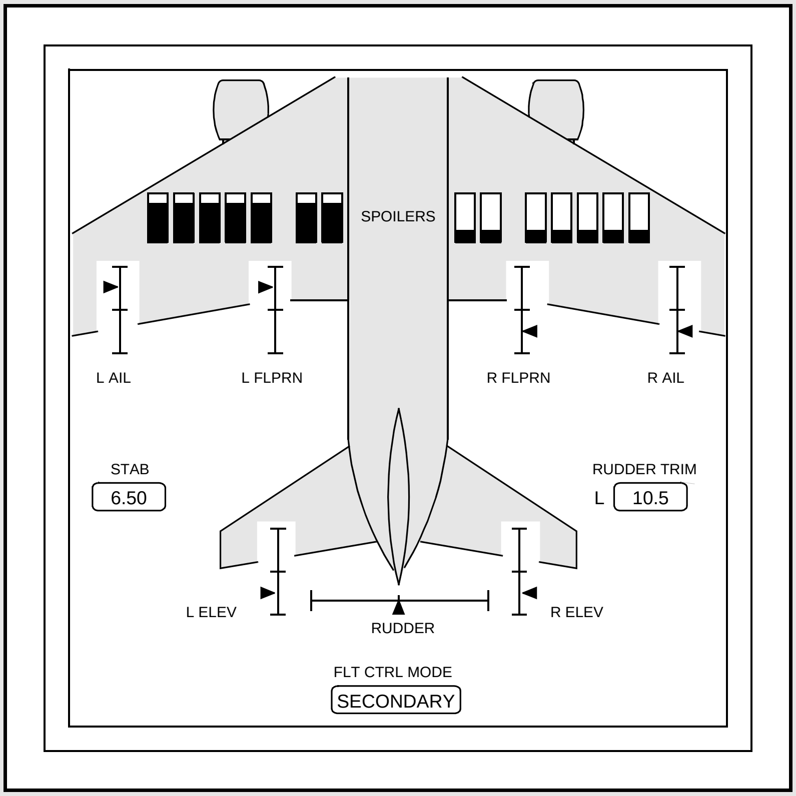
The pilots use the control wheels and cables to mechanically control signals to spoilers 4 and 11. The captain's or first officer's control wheel controls the position of a hydraulic control valve on the spoiler PCUs. This causes the hydraulic PCUs to move the spoilers.

In normal mode only, the PFCs calculate commands to electrically control spoilers 4 and 11 as speed brakes.

Spoilers 4 and 11 deploy to a maximum of 45 degrees.

HORIZONTAL STABILIZER

The pilots use two alternate pitch trim levers and a set of cables to send mechanical control signals to the horizontal stabilizer. Two alternate pitch trim levers on the control stand connect to valves on each stabilizer trim control module (STCM).If the pilots move both levers in the same direction, this moves the valves in the STCMs. This sends hydraulic fluid to the hydraulic motors and brakes to move the horizontal stabilizer.



PFCS Synoptic Display

PFCS Indications

PFCS Indications

SYSTEM MONITORING

The PFCs do a self-test and a test of the ACEs each time the system gets power. A failure of a test may cause an EICAS status message.

SYNOPTIC DISPLAY

The flight controls synoptic display gives the flight crew a graphical overview of the flight control system. The display has this information:

- Primary flight control surface positions
- Failures
- Current flight control mode.

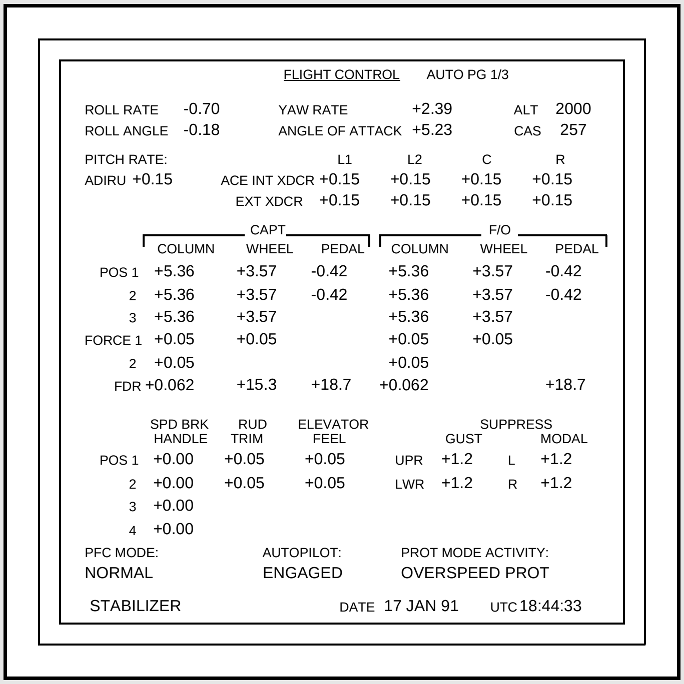
Trim position of the stabilizer and rudder shows in degrees.

The synoptic display helps the flight crew understand the impact of flight control system failures.

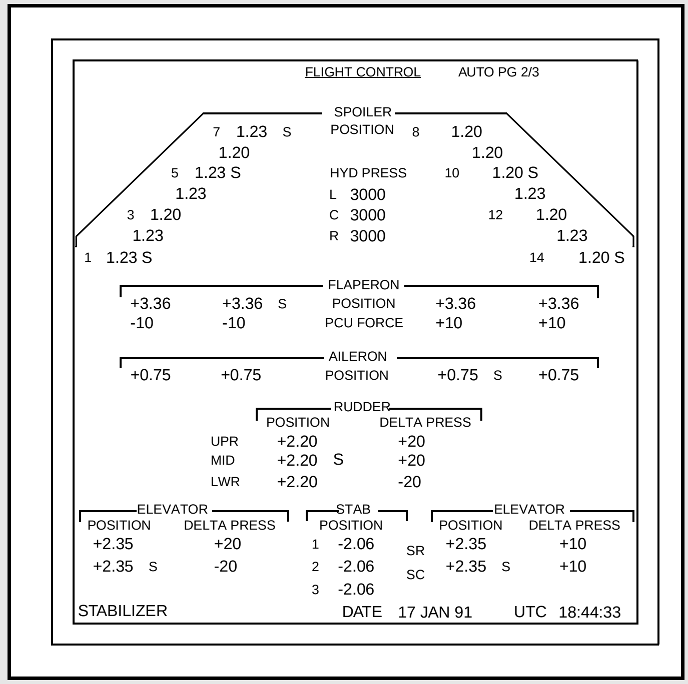
It is not necessary to use the synoptic display to do any normal or non-normal crew procedures.

MAINTENANCE PAGES

There are three maintenance pages. Maintenance personnel use the maintenance pages to do maintenance functions, such as rigging, and to do checks of the discrete outputs from the PFCS components.

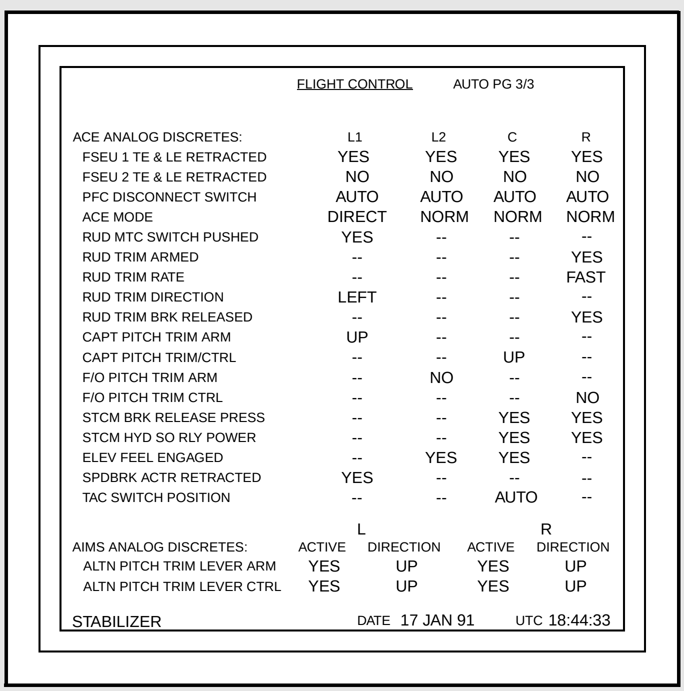


PFCS Maintenance Page – Controls



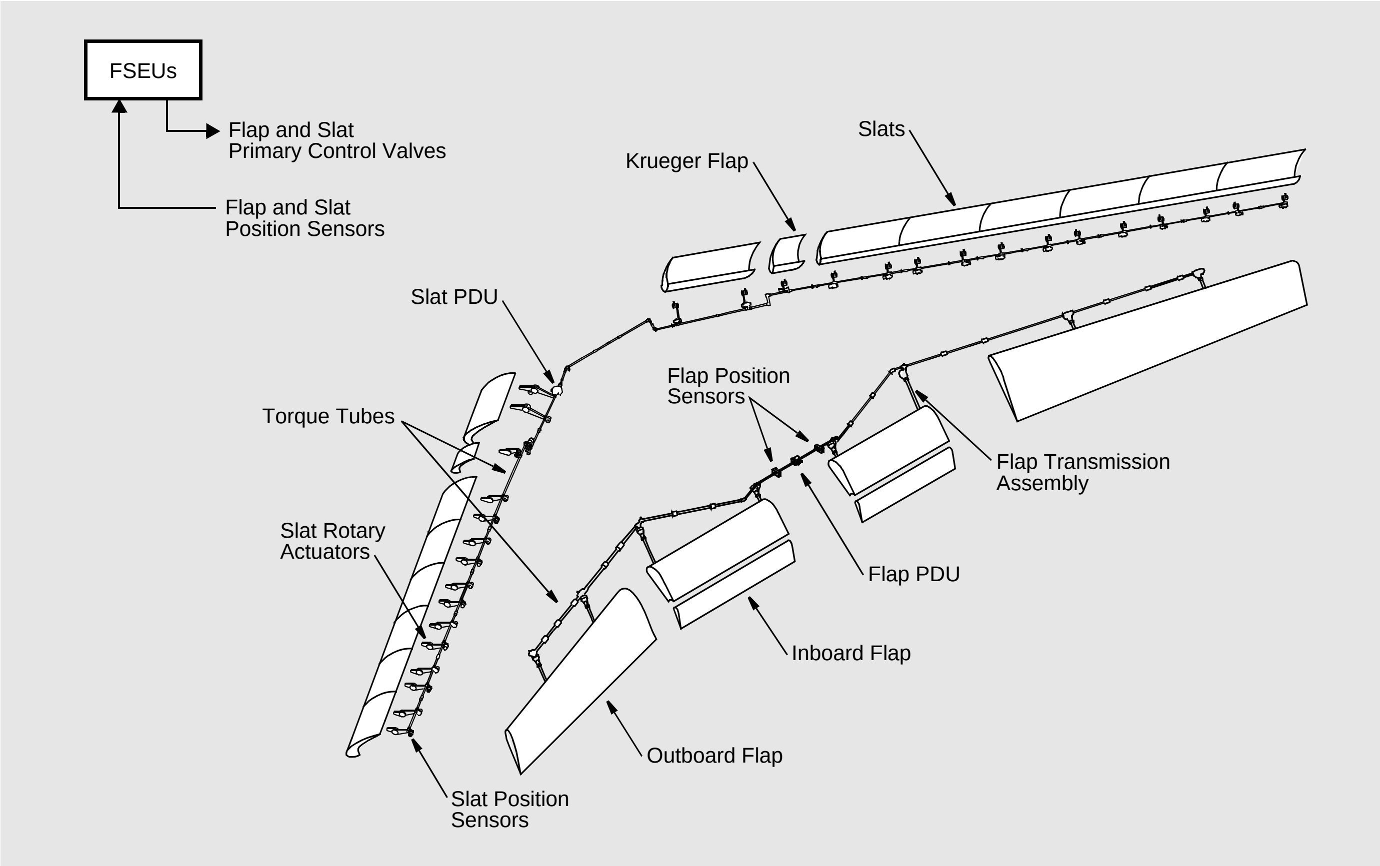
PFCS Maintenance Page – Surfaces

PFCS Indications



PFCS Maintenance Page – Discretes

PFCS Indications



High Lift Surfaces

High Lift Surfaces

TRAILING EDGE FLAPS

The trailing edge flaps have an inboard double slotted flap and an outboard single slotted flap on each wing.

The flaps have six positions: up, 5, 15, 20, 25, and 30. The takeoff setting is at 5, 15, or 20. The landing setting is at 25 or 30. The flaps retract at settings 1 and up.

Hydraulic or electric motors on the flap PDU turn the flap torque tubes. The torque tubes operate the flap transmission assemblies. The transmission assemblies use a ballscrew and gimbal to extend and retract the flaps.

LEADING EDGE SLATS

The leading edge slat system has seven slats and one Krueger flap on each wing. The Krueger flap seals the gap between the engine strut and the inboard slat.

The slats have these three positions:

- Cruise (retracted)
- Takeoff (sealed)
- Landing (gapped).

The Krueger flap has only two positions: retracted and deployed.

Hydraulic or electric motors on the slat power drive unit (PDU) turn the slat torque tubes. The torque tubes drive the slat rotary actuators. The rotary actuators extend and retract the slats with a rack and pinion drive.

FLAP/SLAT ELECTRONIC UNITS

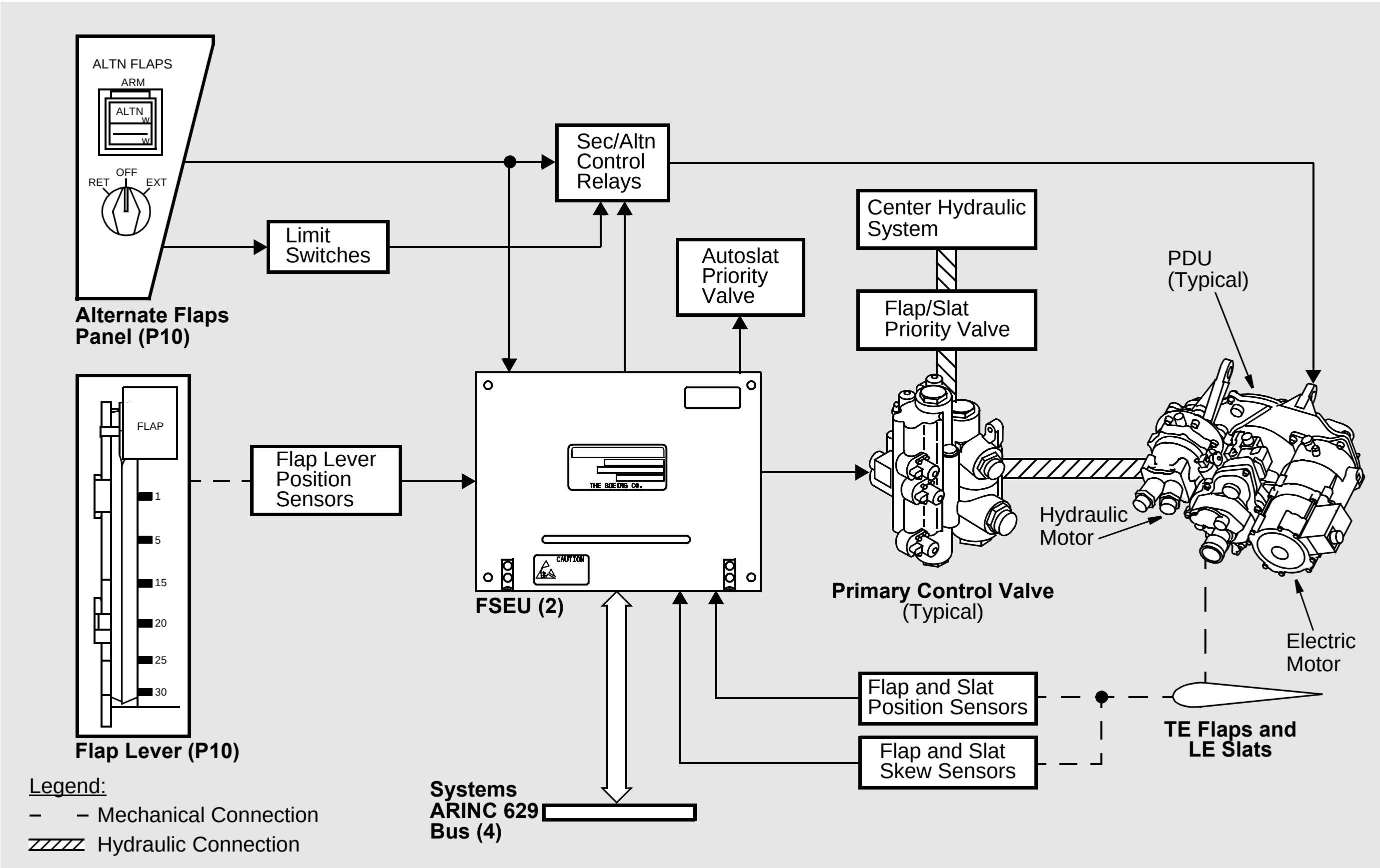
Two identical and interchangeable flap/slat electronic units (FSEUs), in the main equipment center, process the high lift commands.

FLAP POSITION SENSING

There are two position sensors on each side of the flap PDU. These sensors supply the flap position to the FSEUs for control and monitoring. The FSEUs also receive inputs from 16 flap skew sensors. These sensors are on the flap linkages and monitor for flap misalignment.

SLAT POSITION SENSING

There are two position sensors at each end of the slat torque tubes. These sensors supply the slat position to the FSEUs for closed loop control and for monitoring. The FSEUs also receive inputs from 12 slat skew/loss proximity sensors. These sensors monitor for slat misalignment and for a lost slat.



HLCS Operational Overview

HLCS Operational Overview

The high lift control system (HLCS) extends and retracts the trailing edge and leading edge devices.

The HLCS operates in three modes:

- Primary
- Secondary
- Alternate.

PRIMARY MODE

The primary mode has a fly-by-wire closed loop control and operates hydraulically. The pilot controls the HLCS with the flap lever on the control stand. The lever has seven detents with gates at detents 1 and 20. Four sensors transmit the flap lever position to the two FSEUs.

The FSEUs receive and transmit data on the systems ARINC 629 buses. Other airplane systems supply airspeed and hydraulic data through these buses for the high lift protection functions.

The FSEUs control solenoids in the primary control valves. These valves control the hydraulic power to the hydraulic motors on the flap and slat PDUs. These motors operate the flap and slat mechanisms.

The FSEUs also operate the autoslat priority valve for autoslat extension when the airplane is near a stall condition.

SECONDARY MODE

If the FSEUs find a fault in primary mode, they switch to the secondary mode. The secondary mode operates electrically, but the pilot control is the same as in the primary mode.

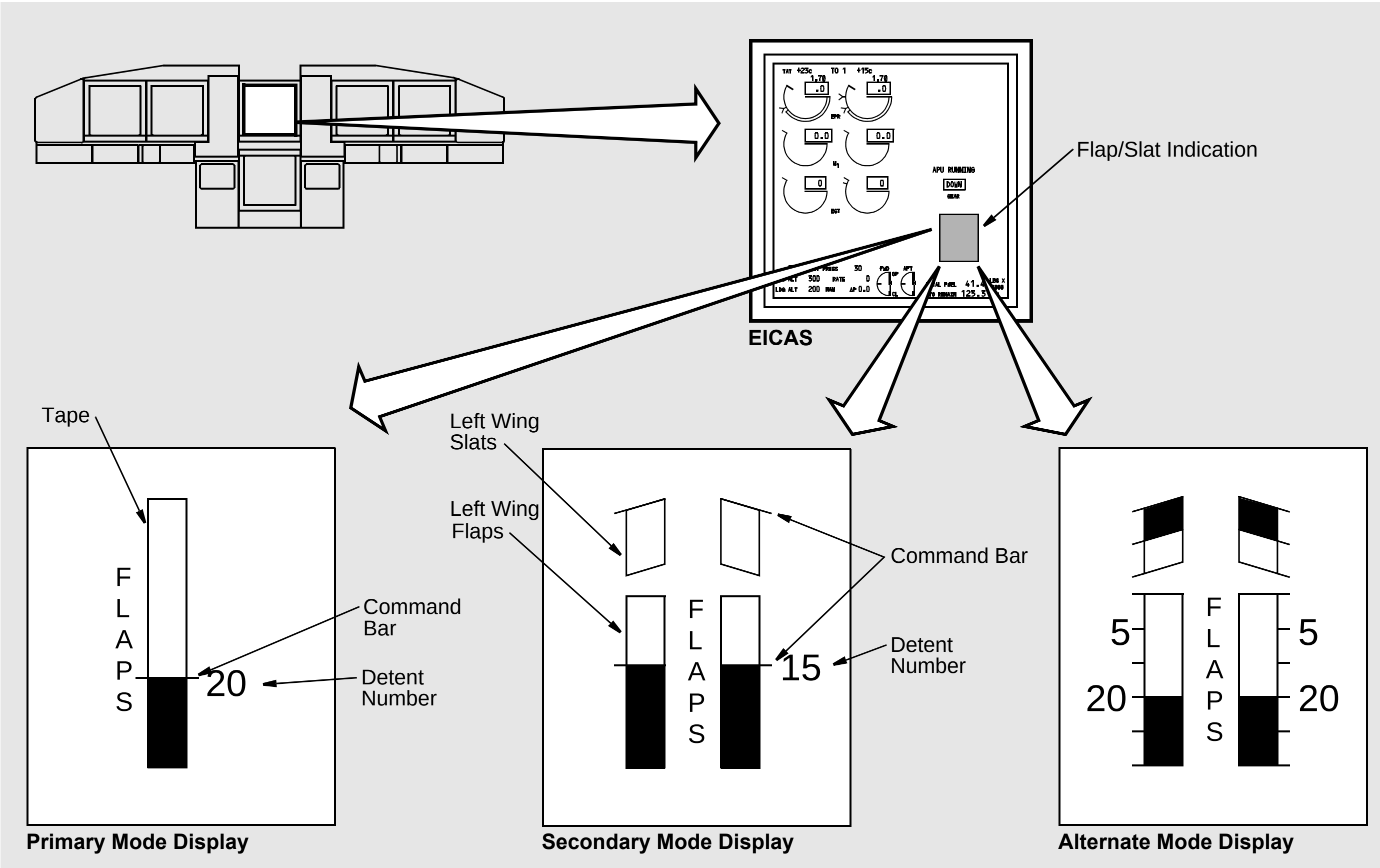
The FSEUs control the secondary/alternate control relays. These relays engage clutches and supply electrical power to electric motors on the flap and slat PDUs. The electric motors move the flap and slat mechanisms.

ALTERNATE MODE

The alternate mode is independent of the FSEUs and uses electrical power to move the flaps and slats.

The pilot selects the alternate mode with the alternate flaps arm switch. The pilot then selects extend or retract using the alternate flaps selector. These switches are on the control stand, outboard of the flap lever. These switches control the secondary/alternate control relays for the flaps and slats in the same way as the secondary mode.

The alternate mode uses flap and slat limit switches to limit the flaps to 20 degrees and the slats to the sealed position.



Flap and Slat Indications

Flap and Slat Indications

The EICAS display shows all HLCS indications. The FSEUs supply surface positions to the primary display system which shows the indications in the three modes of operation.

PRIMARY MODE DISPLAY

The primary mode display is a single white tape that moves down as the flaps and slats extend. A magenta command bar and detent number shows the flap setting. The command bar and detent number change to green when the surface position agrees with the flap lever command.

The primary mode display goes out of view 10 seconds after the flaps and slats fully retract and the flap lever is in the UP position.

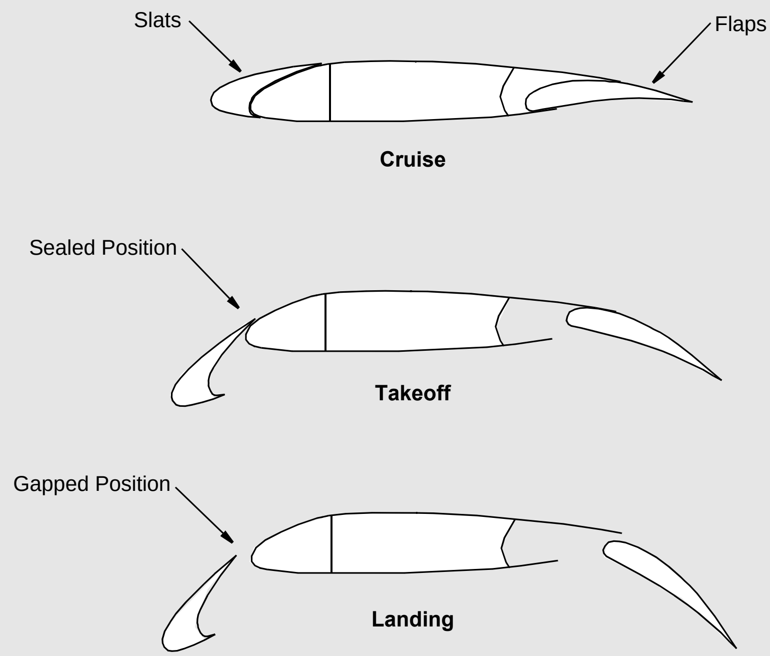
SECONDARY MODE DISPLAY

When the system changes to the secondary mode, the flap/slat indication expands to show position tapes for both the slats and flaps on each wing. A magenta command bar and detent number shows the flap setting. The command bar and detent number change to green when the surface position agrees with the flap lever command. The tape, command bar, and detent number change to amber to show faults in the secondary mode.

The secondary mode display goes out of view 10 seconds after the flaps and slats fully retract and the flap lever is in the UP position.

ALTERNATE MODE DISPLAY

The alternate mode display shows when the alternate system is armed. This display is similar to the secondary mode display, except the command bars do not show and tick marks show flap lever detent positions. The alternate mode uses X’s on the tapes to show faults.



HLCS Functions

HLCS Functions

The FSEUs control the sequence of the flaps and slats extension and retraction. The FSEUs also supply protection functions such as autoslat extension, load relief and skew or asymmetry.

FLAP AND SLAT SEQUENCE

The flaps and slats extend and retract in sequence. This sequence is different in the three modes of operation.

In the primary mode, the slats extend to the sealed position before the flaps extend. When the flap lever is at 25 or 30, the slats extend to the gapped position before the flaps extend from the 20 position.

In the secondary mode, the slats extend to the gapped position before the flaps extend.

In the alternate mode, the slats and flaps extend at the same time.

In all three modes, the flaps retract before the slats retract.

AUTOSLAT

The autoslat function improves the airplane stall performance near stall conditions. The autoslat function is available only in the primary (hydraulic) mode.

When the airplane is near a stall condition, the FSEUs send a command to extend the slats from the takeoff (sealed) position to the landing (gapped) position. The slats return to the takeoff position when the airplane is no longer near a stall condition.

LOAD RELIEF

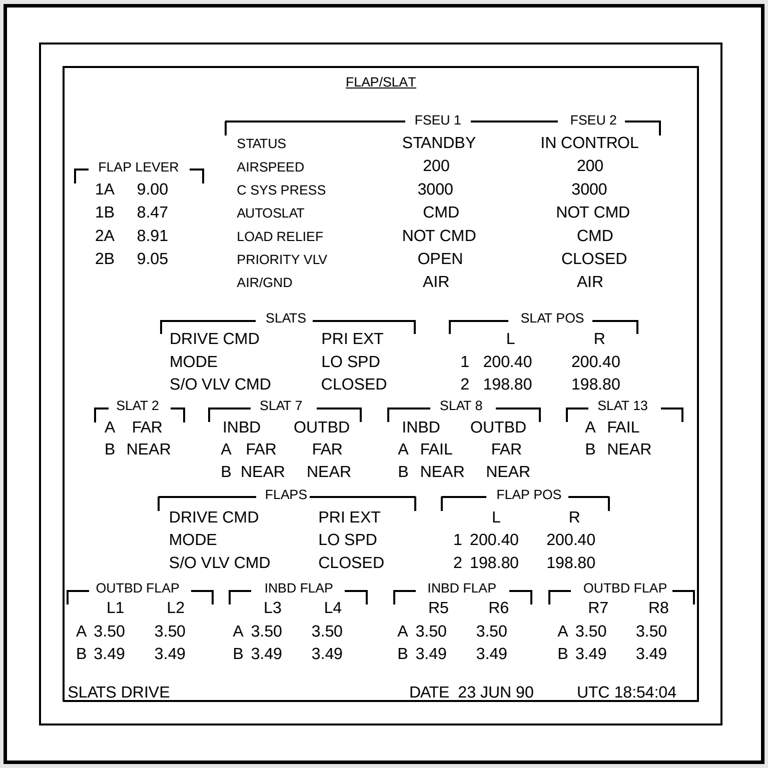
The flap and slat load relief functions protect the flaps and slats from airload damage. The flap load relief function is available only in the primary (hydraulic) mode. The slat load relief function is available only in the secondary (electric) mode.

When the airspeed is more than set levels, the flaps retract to a new position. This new position depends on airspeed. The slats retract from the gapped to the sealed position. When the airspeed is less than the reset value, the flaps extend to the commanded position. The slats extend to the gapped position.

When load relief is active, the EICAS display shows a LOAD RELIEF message adjacent to the flap/slat indication.

SKEW OR ASYMMETRY

When the FSEUs detect a skew or asymmetry, they shut down the flap or slat drive.



HLCS Maintenance Page

HLCS Maintenance Page

HLCS Maintenance Page

There is one maintenance page for the HLCS. Maintenance personnel use the maintenance page to do maintenance functions, such as rigging, and to do checks of the discrete outputs from the HLCS components.

Features

PNEUMATIC

Two controllers supply these functions:

- Pneumatic system control
- Pressurization system control
- Air conditioning pack flow schedule control
- Air conditioning pack backup control.

The only crew action is to select auto operations or off.

The system automatically removes pneumatic loads if the airplane stalls.

The controller BITE monitors and tests components to the LRU level.

AIR CONDITIONING

The airplane has seven temperature control zones. The system can have as many as sixteen zones to permit options, without adding more controllers.

Two controllers control the air conditioning system. They both do zone and pack control. Each controller has two control channels.

The controller BITE monitors and tests components to the LRU level.

Air bearings in the air cycle machine, and a mechanical water collector reduce service needs.

An optional gasper system gives additional air circulation at each passenger seat.

Electric heaters give additional heat in the flight deck, galleys, and door areas for crew and passenger comfort.

CREW REST AREA AIR DISTRIBUTION (-200 IGW AND -300)

Air is provided to an optional lower lobe attendants rest (LLAR) from the air conditioning packs. Electric heaters in the LLAR give additional heat to the module.

EQUIPMENT COOLING

There are forward and aft equipment cooling systems.

The forward system uses supply and exhaust fans to cool equipment in the MEC, forward equipment center, and flight deck.

The aft system uses the lavatory and galley ventilation system. It pulls air through aft electrical equipment.

CARGO COMPARTMENT HEATING AND VENTILATION

Waste heat from the exhaust part of the forward equipment cooling system heats the forward cargo compartment.

Hot air from the pneumatic system heats the aft and bulk cargo compartments.

Ventilation permits the transport of animals in the bulk cargo compartment.

CABIN PRESSURE CONTROL

Two controllers control the pressurization system. They also control the pneumatic system.

The system has two outflow valves.

System operation is automatic. The flight management computing function (FMCF) of AIMS supplies the necessary flight plan data. A backup mode controls cabin pressurization if the flight crew does not use the FMCF for the flight. Manual outflow valve control is also available.

Pneumatic

Air from the pneumatic system does these functions:

- Starts the APU
- Starts the engines
- Ventilates the cabin
- Pressurizes the cabin
- Prevents ice formation on the wing slats
- Causes air flow across the total air temperature probes
- Pressurizes hydraulic reservoirs and potable water tanks
- Supplies power to the air driven hydraulic pumps
- Supplies aft, and bulk cargo heat.

These are the sources of air for the pneumatic system:

- Ground air compressors
- APU load compressor
- Engine bleed air system.

There are two air supply cabin pressure controllers (ASCPCs) in the main equipment center. They use data about the air sources and air users to select the valve positions.

The data for automatic operation comes from these:

- Airfoil and cowl ice protection system (ACIPS)
- Autopilot flight director system (AFDS)
- Airplane information management system (AIMS)
- Air supply cabin pressure controllers (ASCPC)
- Auxiliary power unit controller (APUC)
- Cabin temperature controller (CTC)
- Duct leak and overheat detection (DLODS)
- ECS miscellaneous card (ECSMC)
- Electronic engine control (EEC)
- Electrical load management system (ELMS)
- Flap slat electronics unit (FSEU)
- Hydraulic interface module (HYDIM) cards
- Overhead panel ARINC 629 system (OPAS)
- Warning electronic unit (WEU)
- Weight on wheels (WOW) cards.

The engine bleed part of the system has these three control levels:

- Digital
- Analog
- Pneumatic.

Digital is the primary mode. Analog and pneumatic are backup modes. The ASCPCs give digital and analog control. Valves give pneumatic control.

The ASCPCs monitor system operation to the level of the line replaceable unit (LRU). The central maintenance computing system (CMCS) gives fault information.

The ASCPCs control the:

- Engine bleed air supply
- Isolation valves
- APU shutoff valves.

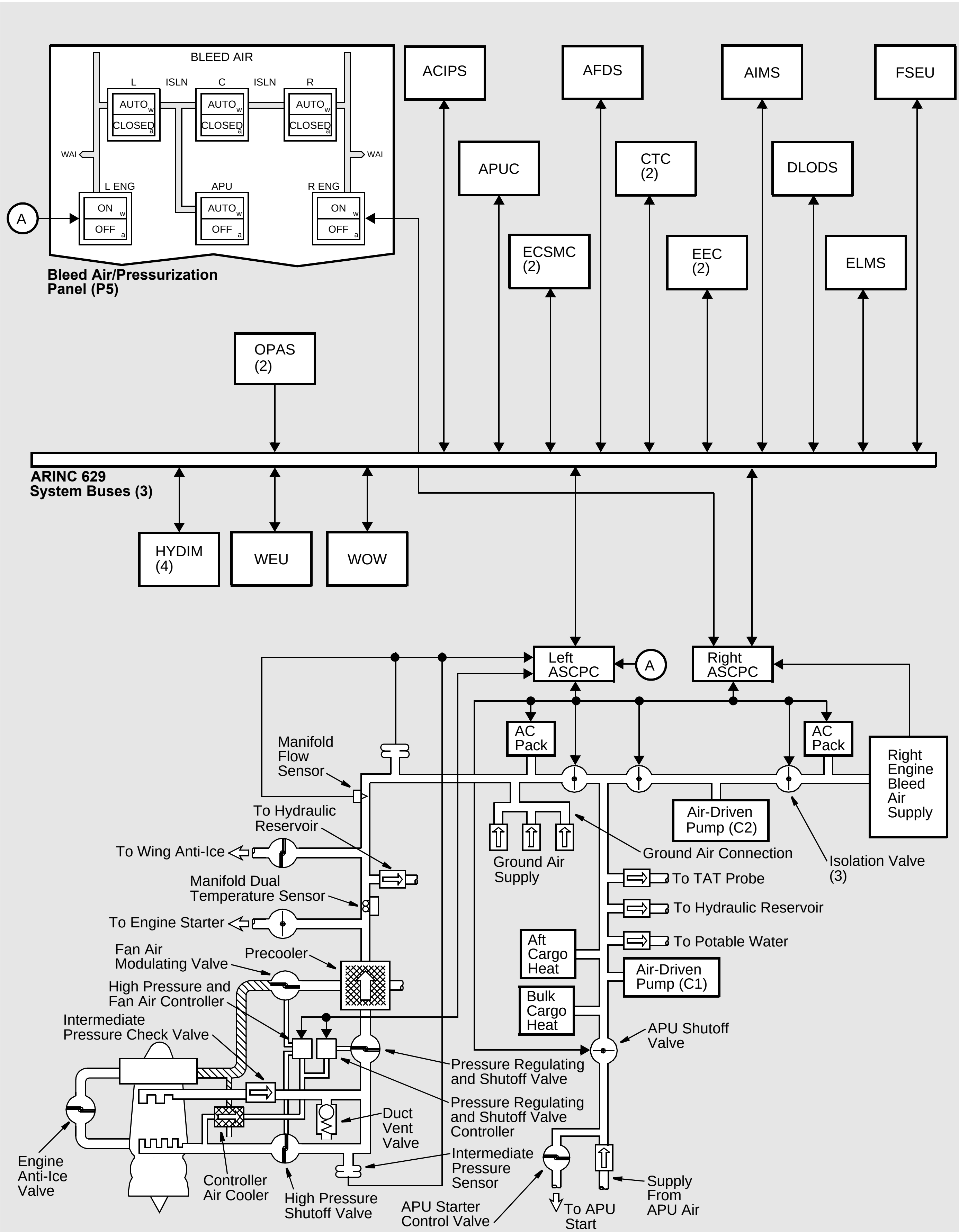
Sensors (not shown) in the system give the controllers pressure, temperature, valve position, and flow data.

Engine bleed air comes from either an intermediate stage or the high stage of the engine high pressure compressor. The controllers use engine pressure and airplane altitude to make the stage selection.

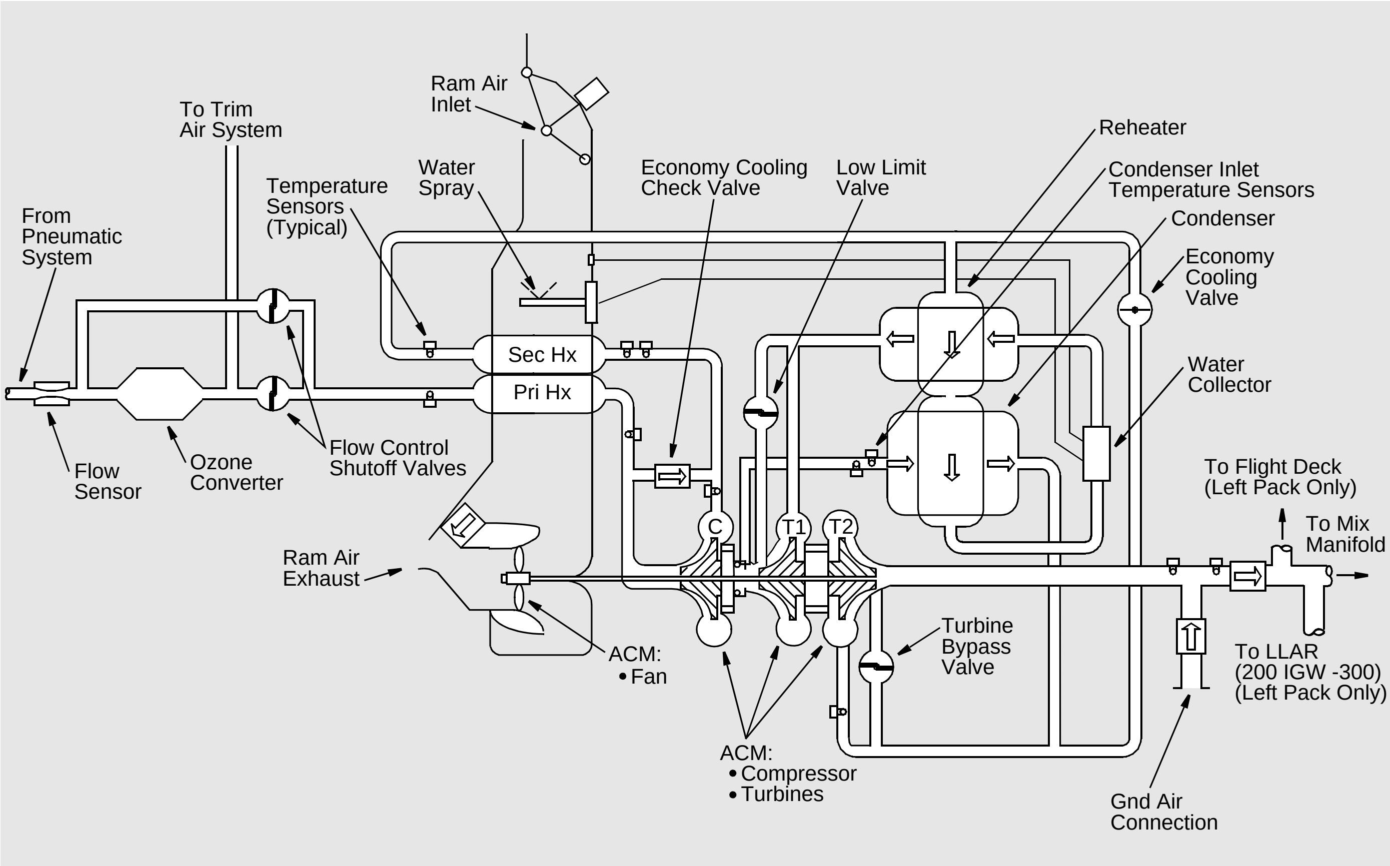
The high pressure shutoff valve (HPSOV) controls system pressure when the high stage supplies the bleed air. A check valve prevents reverse flow through the intermediate pressure port. The pressure regulating and shutoff valve (PRSOV) controls system pressure when the intermediate stage supplies the bleed air.

Air from the engine fan section cools engine bleed air in the precooler. If the bleed air does not cool sufficiently, the PRSOV reduces the air flow to keep the temperature to a limit.

Over-pressure and over-temperature bleed air and duct leak conditions causes a system protective shutdown.



Pneumatic System



Pack Airflow

Pack Air Flow

Two flow control and shutoff valves control air flow from the pneumatic system to each pack. One valve is open at a time.The upper valve is open at altitudes up to 26,000 feet (7930m). Above 26,000 feet the lower valve opens to let air go through the ozone converter. When the airplane goes below 24,000 feet (7315m), the upper valve opens and the lower valve closes.

Heat exchangers use ambient ram air to remove heat from the pneumatic system and the air cycle machine (ACM) compressor. The air cools more in the condenser. The water collector removes water that has condensed and sends it to the ram air for evaporative cooling. Air from the collector warms in the reheater to remove any ice particles.Air expands in the turbines of the ACM to give cooling.

The cabin temperature controller (CTC) controls the turbine bypass valve, low limit valve, and ram air doors to adjust the air temperature from the packs. The controllers use data from sensors for control and indication.

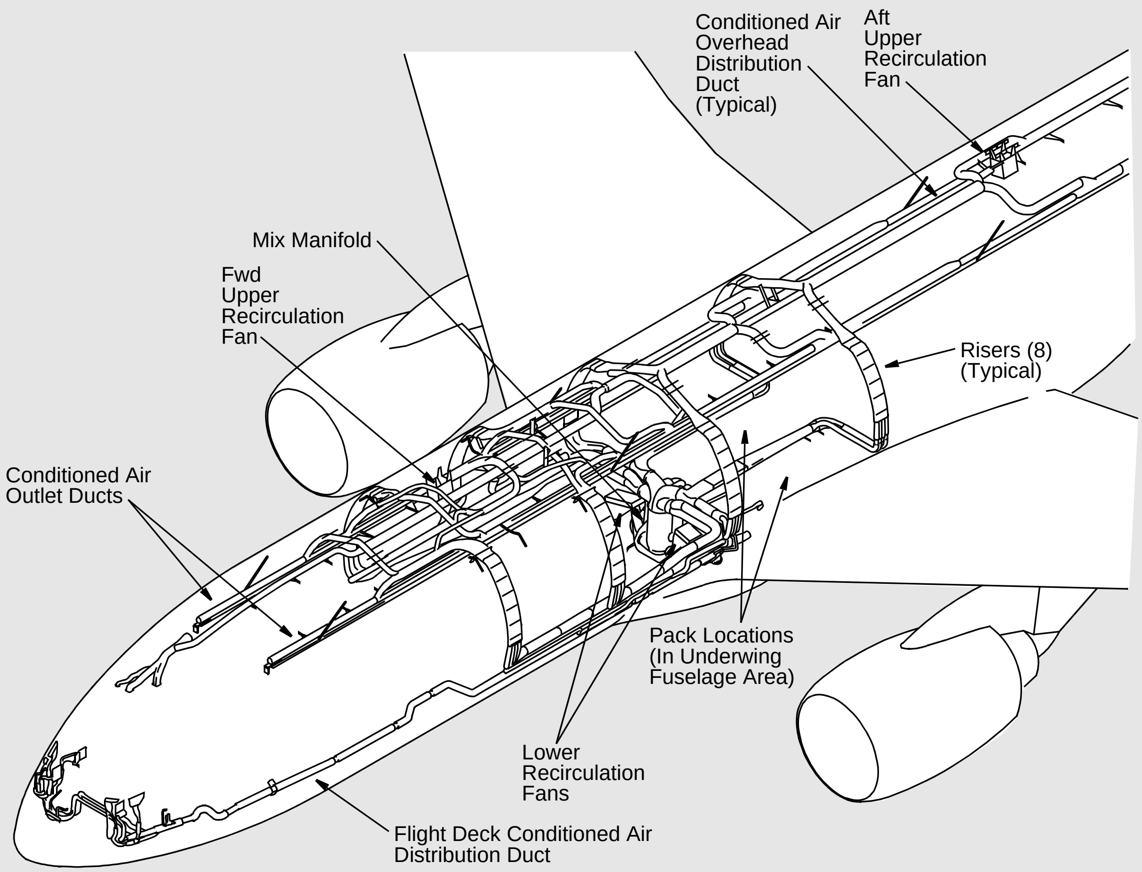
When less cooling is necessary, the pack goes to the economy cooling mode. The economy cooling valve opens to decrease the air flow through the compressor and turbine. This decreases the pneumatic pressure needed for pack air flow.The CTCs modulate the turbine bypass valve and ram air doors to control pack outlet temperature.

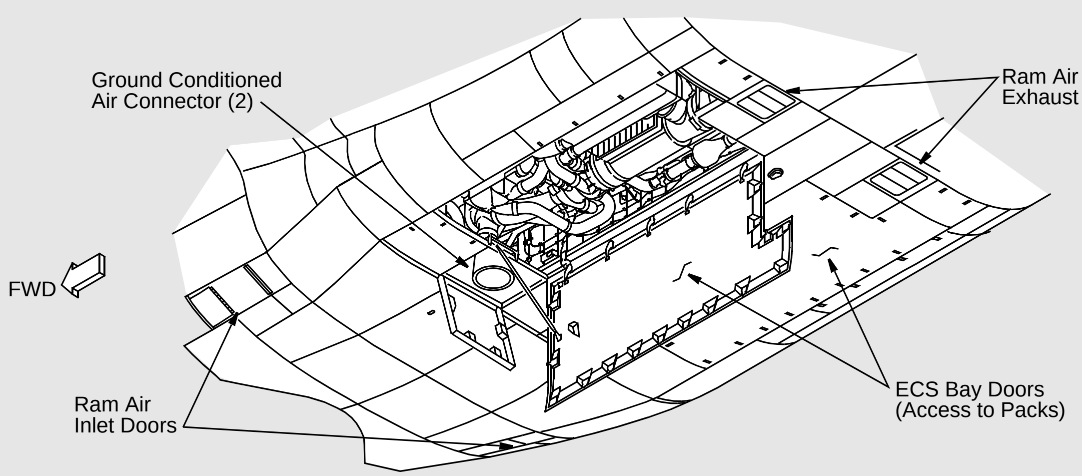
If there is a failure of the ACM, or the condenser inlet temperature sensors, or if the economy cooling valve fails open, the pack can operate in the standby cooling mode. Air goes through the economy cooling check valve, the economy cooling valve, and the turbine bypass valve. It does not go through the ACM. The CTC modulates only the ram air doors to control cooling air flow through the heat exchangers.

Distribution Air Flow

Connections for ground conditioned air are in the ECS bays in the ducts that come from the packs. Normally air from the left side goes to the flight deck and the mix manifold and air from the right side goes only to the mix manifold.

Air from the left pack also goes to the optional LLAR (-200ER and -300). The mix manifold is in the aft end of the forward cargo compartment. Ducts and risers for each zone connect the mix manifold to conditioned air distribution ducts above both passenger compartment aisles. The ducts have outlets that let air go into the passenger compartment.





Underwing Fuselage Area

Distribution Airflow

Air Conditioning Control

There are two cabin temperature controllers (CTCs) that give normal air conditioning control. Each CTC has two channels for redundancy. There are two air supply cabin pressure controllers (ASCPCs) that give backup control.

The left controllers control these left components:

- Flow control and shutoff valves
- Air conditioning pack
- Trim air system.

The right controllers control the right side.

There are two control panels. The flight crew uses the air conditioning panel on the P5 to do these functions:

- Operate the air conditioning packs
- Operate the recirculation fans
- Set the flight deck temperature
- Set the cabin temperature.

The cabin crew can use the cabin temperature screen on cabin services system (CSS) control panels to adjust the temperature of each cabin zone 10F (6C) above or below the set temperature.

Sensors in the flight deck and passenger zones give temperature information to the controllers. The controllers control the pack to get air temperature for the zone that is set the lowest. The controllers use information from the temperature sensors in the mix manifold to adjust the pack temperature because of the temperature of recirculation air.

The controllers control the trim air system to warm the air that goes to zones that are set higher than the lowest set temperature. There are temperature sensors in the ducts that carry air to the zones. The controllers use their information to control the packs and trim air systems.

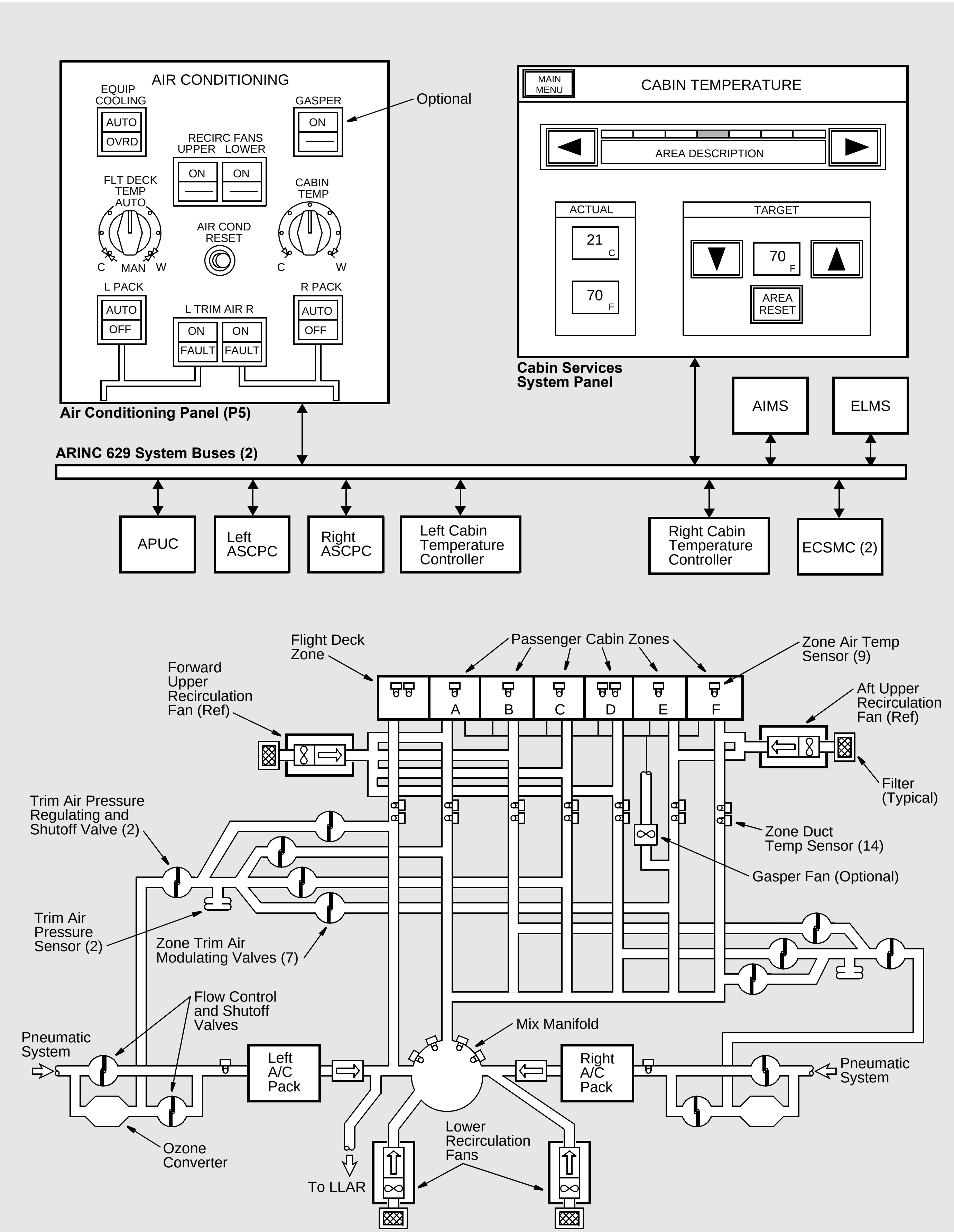
Recirculation

Air from the passenger cabin goes through return air grilles to the area between the fuselage skin and sealed cargo compartments. Some of this air goes out of the airplane through the pressurization outflow valves.

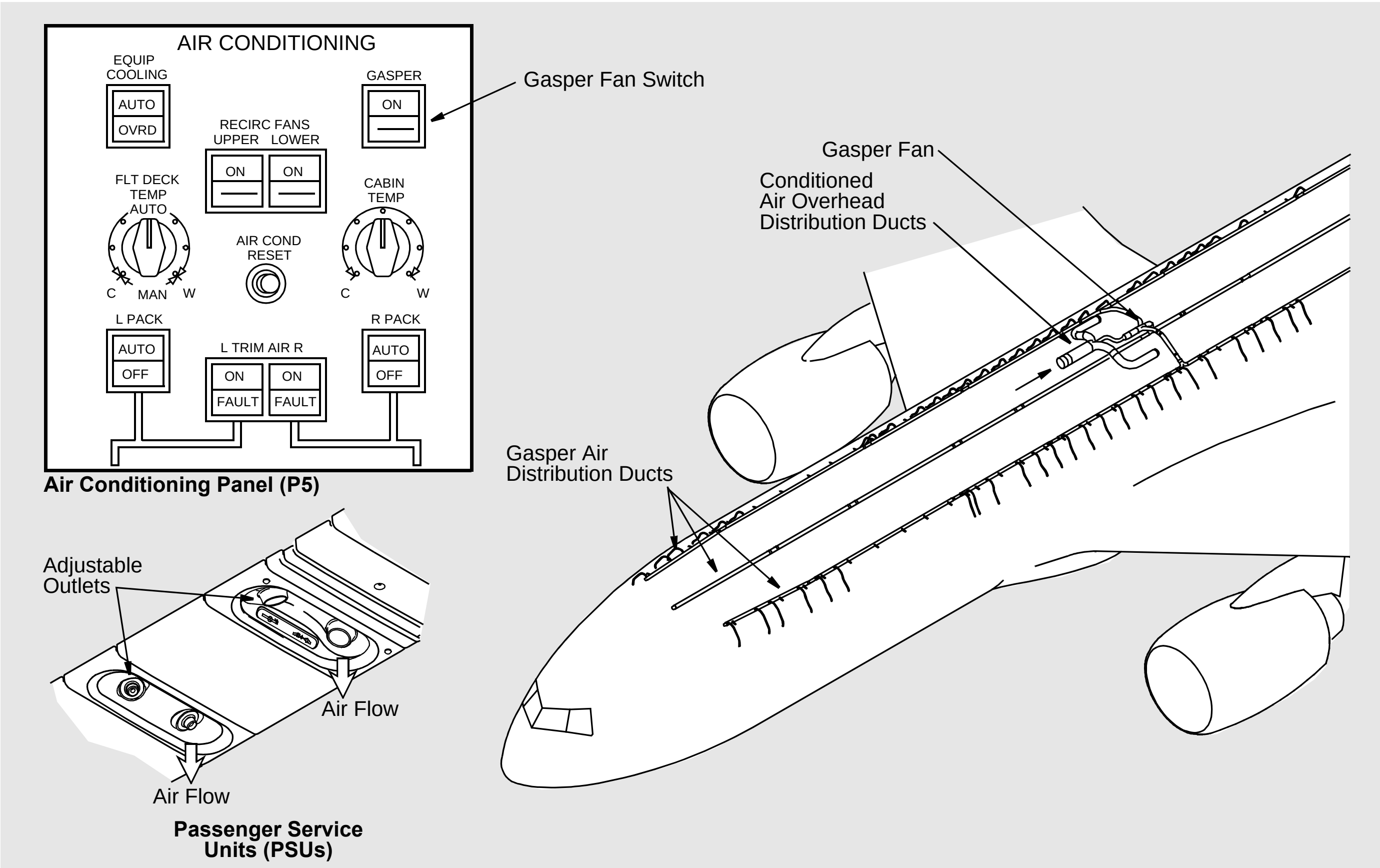
The lower recirculation fans get air from the area between the fuselage skin and sealed cargo compartments. The upper recirculation fans get air from above the passenger compartment ceiling near passenger doors two and three. They move the air through filters into the distribution system.

About one-half of the air in the distribution system comes from the recirculation fans. This decreases the quantity of bleed air from the engines.

The CTCs control the operation of the fans.The environmental control system miscellaneous control cards (ECSMC) monitor their operation.



Temperature Control and Recirculation



Gasper

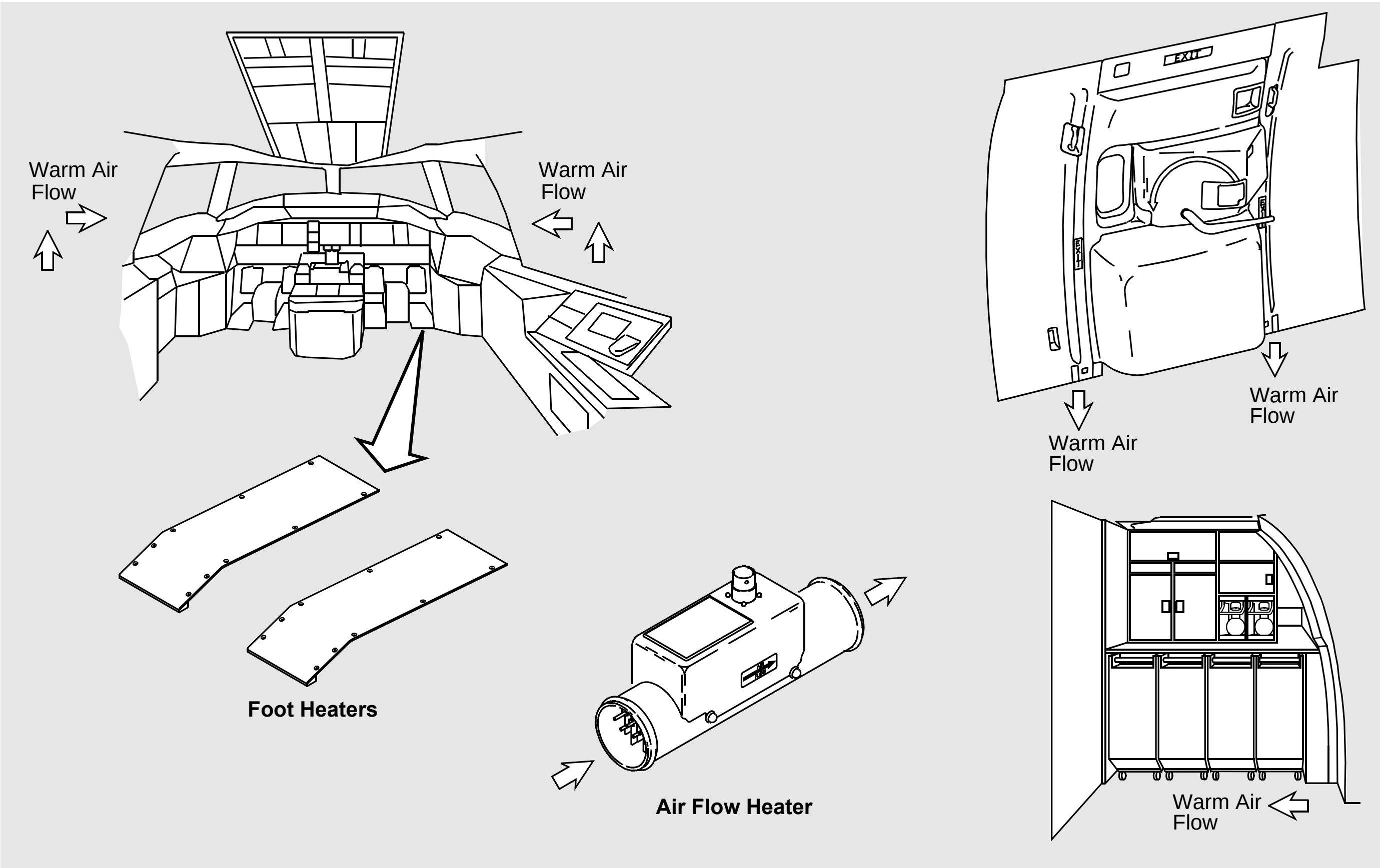
Gasper (Optional)

The gasper system increases air flow in the passenger cabin through outlets in the passenger service units (PSUs). The system has these components:

- Gasper fan above the ceiling in the passenger cabin
- Switch on the air conditioning control panel in the flight deck
- Air outlets on the passenger service units
- Ducts that connect the gasper fan to the air supply and the air outlets.

A switch on the control panel and the two environmental control system miscellaneous card (ECSMC) control the fan. The left card gives backup control.

The fan takes air from the distribution system. It sends it to individual outlets on the PSUs. Passengers can adjust the outlets.



Heaters

Flight Deck, Door, and Galley Heaters

Electric heaters give additional heat to these areas:

- Flight deck
- Galleys
- Passenger entry doors.

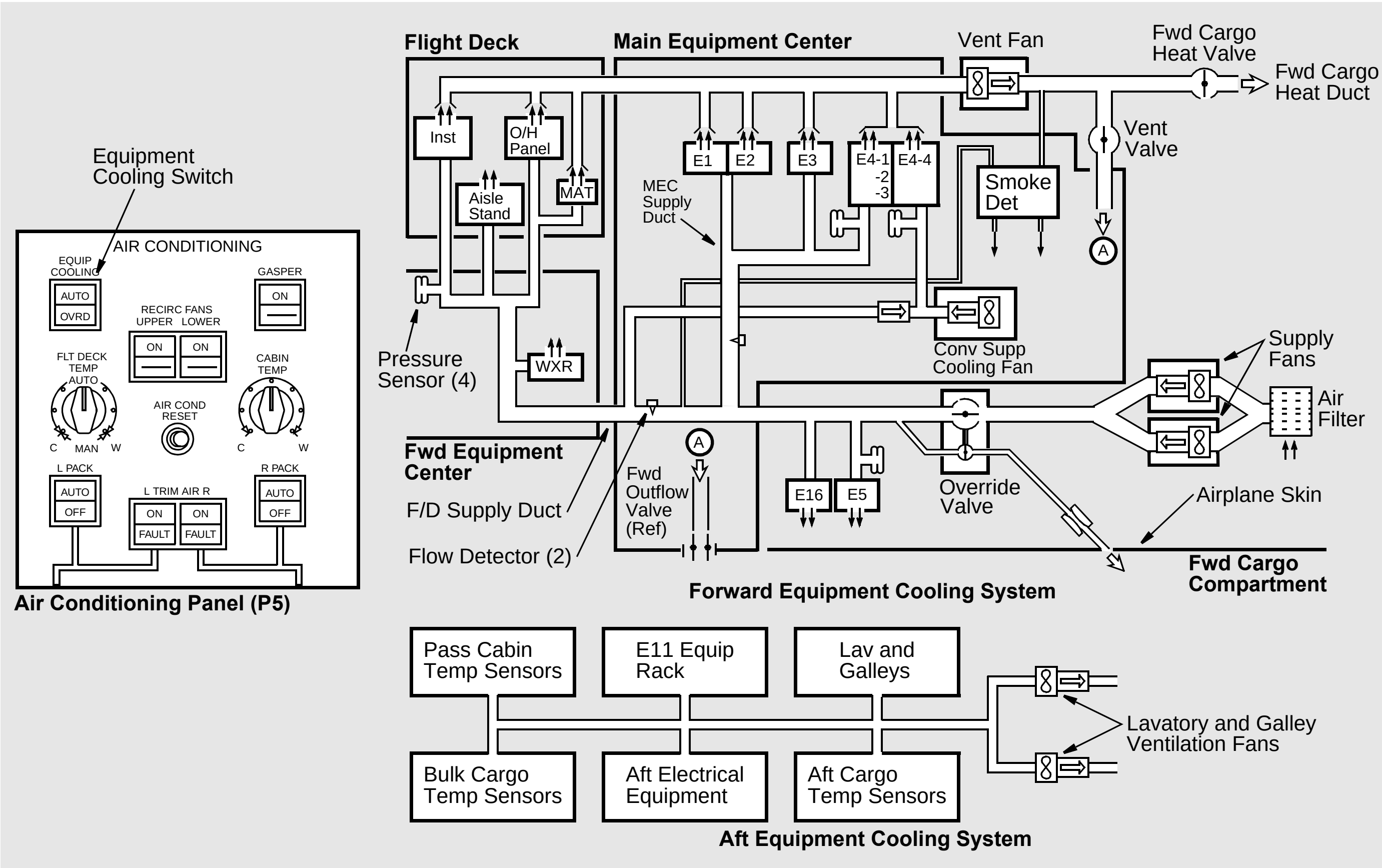
The ELMS and the ECSMCs control the heaters.

There are two different types of heaters in the flight deck. One type heats the air going to the left shoulder of the captain and right shoulder of the first officer. The other type heats the foot area for the captain and first officer. Each of the crew has individual heater controls. The heaters can operate only in the air.

The galley heaters heat the air that goes to the floor area. There is a control switch in each galley. The heater will operate only if a pack is on.

The door heaters heat the air that goes to the bottom of each passenger entry door opening. There are no control switches. Operation is automatic during these conditions:

- Airplane is in the air
- Outside air temperature is less than 35F (2C)
- Pack or recirculation fan is on.



Equipment Cooling and Lavatory and Galley Ventilation Systems

Equipment Cooling and Lavatory and Galley Ventilation

The forward equipment cooling system has two supply fans. The lower fan operates. The upper gives automatic backup. They send air from around the cargo compartment to the override valve. When one disc of this valve is open, the other is closed. Normally the upper disc is open. When the lower disc is open, the valve is in the override position.In the normal position supply fan air goes to this equipment:

- Main equipment center
- E5 and E16 racks near the forward cargo compartment door
- Forward equipment center
- Flight deck.

The vent fan pulls the air from these areas except the E5 and E16 racks. It sends the air to the vent valve and the forward cargo heat valve. When one of these valves is open, the other is closed. The cargo heat valve is part of the cargo heat system. It is open when the outside temperature is less than 45F (7C). At a temperature more than 45F (7C), the vent valve is open. The outlet from the vent valve is near the forward pressurization outflow valve. When the vent valve is open, air goes overboard through the outflow valve.

There is a smoke detector. The supply fans and vent fan push air through the smoke detector. The detector uses LED photoelectric cells to find if there is smoke in the air. There are also flow detectors. Smoke or low flow will cause the system to go to the override mode. Also, the flight crew can use the equipment cooling switch for the override mode. In this mode, the:

- Supply fans stop
- Vent fan stops
- Override valve goes to the override position
- Pressurization pushes air through the equipment and overboard.

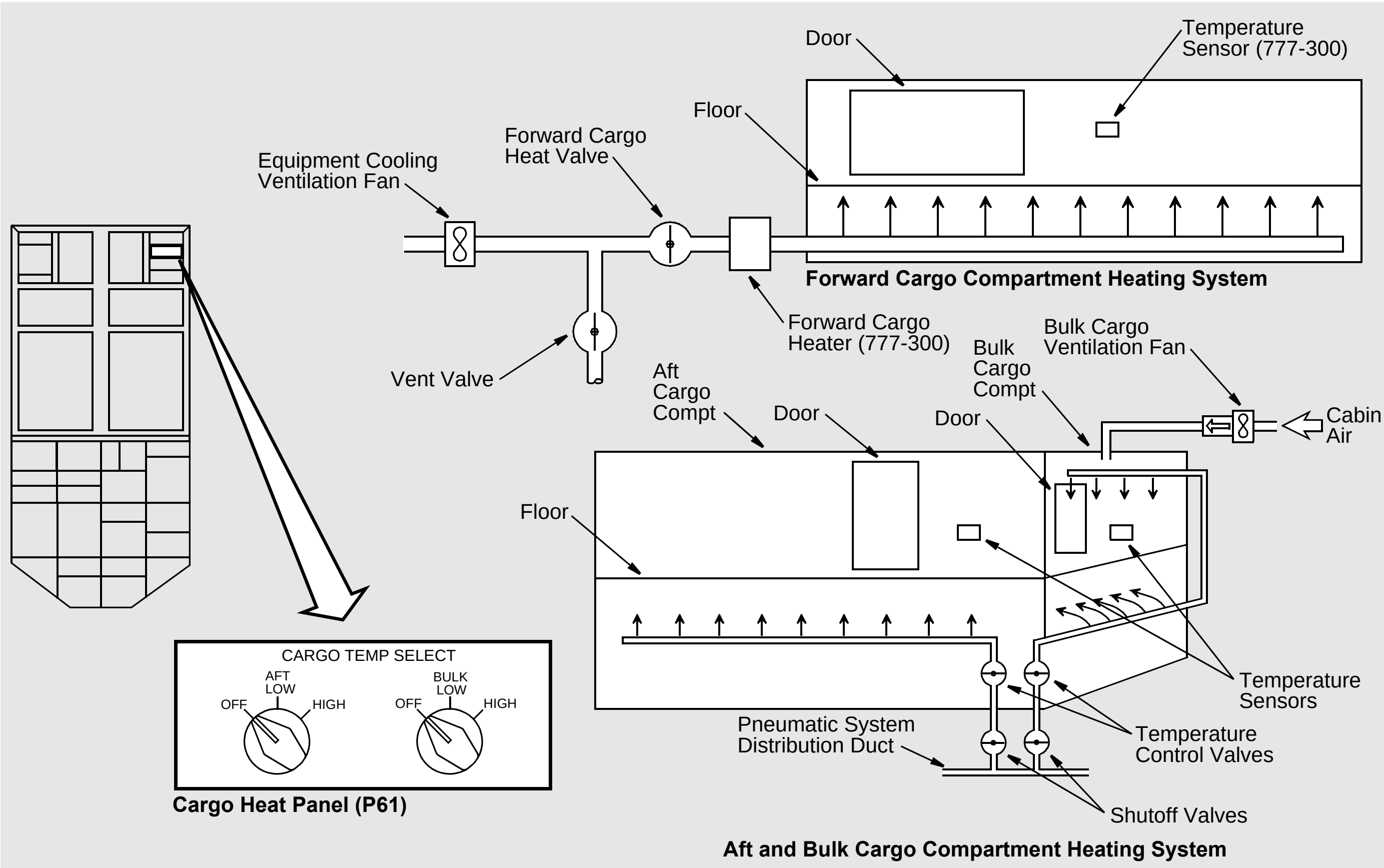
The converter supplemental cooling fan operates when the supply fans are off, to supply cooling air to the backup electrical power system.

There are two lavatory and galley ventilation fans. The right fan operates. The left fan gives automatic backup.The fans pull air:

- Through temperature sensors
- Through equipment on racks
- From lavatories
- From galleys.

The air goes overboard through the aft pressurization outflow valve.

The two ECSMCs control the forward system, and the lavatory and galley vent fans. They use controllers to control the forward system supply fans and the override valve.



Cargo Compartment Heating and Bulk Cargo Compartment Ventilation

Cargo Compartment Heating and Bulk Cargo Compartment Ventilation

The forward, aft, and bulk cargo compartments each have heating systems. The bulk cargo compartment also has a ventilation system.

The forward cargo compartment heating system uses vent air from the forward equipment cooling system. The two ECSMCs give control. There is no control switch.

The AIMS tells the ECSMC when the total air temperature (TAT) is less than 50F (10C). The card tells ELMS to close the vent valve and open the forward cargo heat valve. The warm air flows into the forward cargo compartment.

The aft and bulk cargo compartment heating systems are independent of each other. The ECSMCs control the systems. Air from the pneumatic system is the heat source. Each compartment has these components:

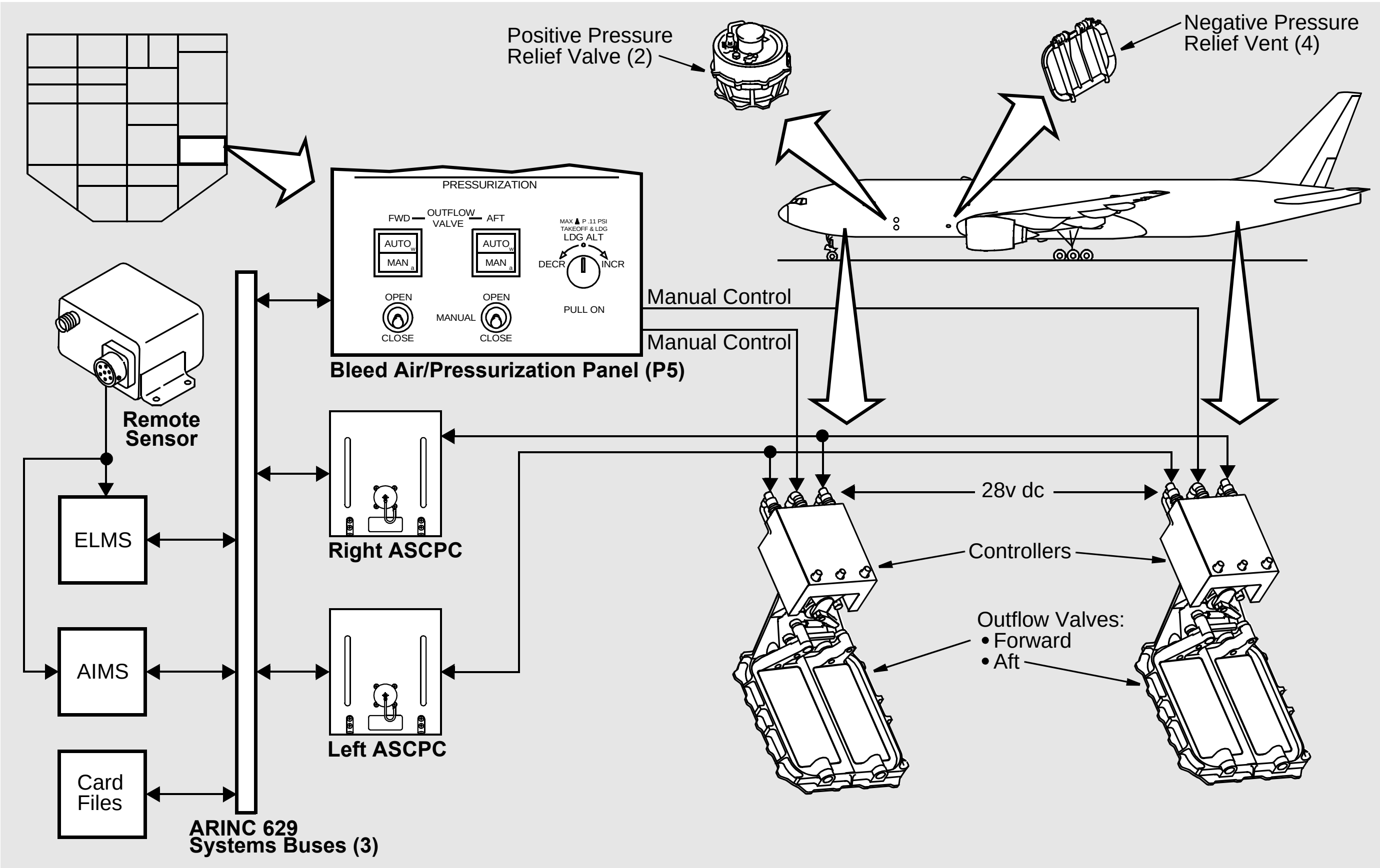
- Shutoff valve
- Temperature control valve
- Temperature sensor
- Control switch on P61.

The valve operation for both compartments is the same.The crew sets HIGH or LOW on the control switch. The ECSMC tells the ELMS to open the shutoff valve.

The ELMS also opens and closes the temperature control valve. When the switch is set to LOW, the control valve opens at a compartment temperature of 40F (4C) and closes at 50F (10C). When the switch is set to HIGH, the valve opens at a compartment temperature of 65F (18C) and closes at 75F (24C).

The crew uses HIGH for the bulk cargo compartment when animals are in the cargo.This turns on the bulk cargo ventilation fan. The fan takes cabin air from around the compartment and blows it into the compartment.

Smoke in the compartments causes the heating and ventilation systems to stop operation.



Cabin Pressure Control

Pressurization

The pressurization system controls the air pressure inside the airplane for the comfort and safety of the passengers and crew.

The pressurization system has these components:

- Control panel on the P5 overhead panel
- Two air supply cabin pressure controllers (ASCPC), in the main equipment center
- Two outflow valve assemblies, one each below the left forward and left aft passenger doors
- Remote cabin pressure sensor in the main equipment center
- Two positive pressure relief valves in the forward cargo compartment, opposite the cargo door
- Four negative pressure relief vents in the forward cargo compartment, two on each side.

The left ASCPC controls cabin pressure automatically. The right ASCPC gives automatic backup control. Control data comes from the:

- AIMS
- Landing altitude select switch on the control panel
- Cabin pressure sensors on the controllers
- Remote cabin pressure sensor
- Weight on wheels card.

The air conditioning packs put air into the airplane. The outflow valves control the rate at which the air goes out of the airplane.

There are two motors on each outflow valve assembly. Each ASCPC uses one motor on each valve assembly to control the valve position. A controller on each valve controls motor operation.

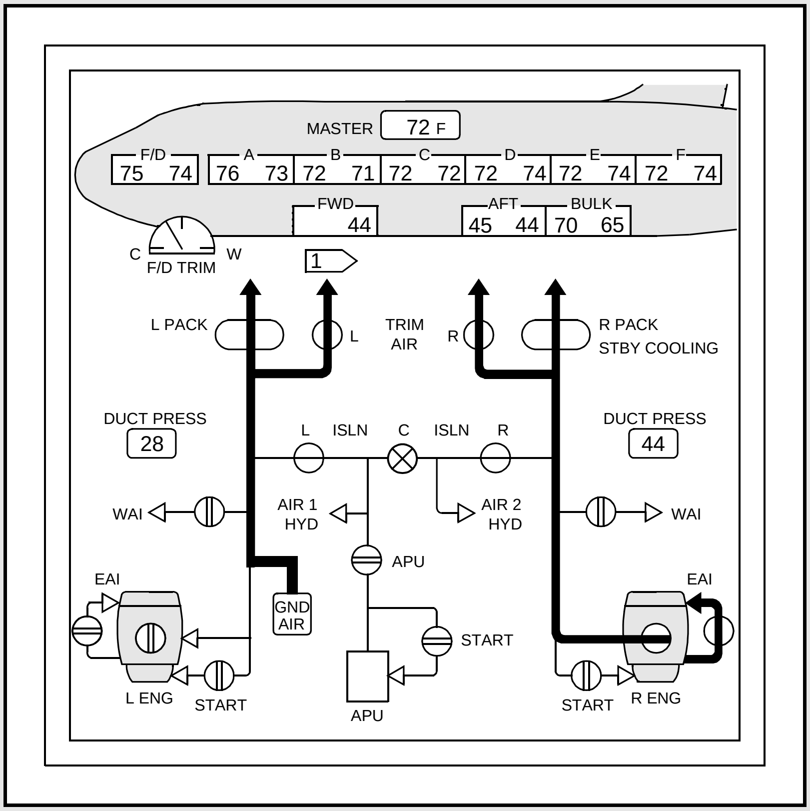
For manual control of the outflow valves, the crew uses the switches on the panel. They use the push-button switch to turn off the auto control for a valve. They use the toggle switch to open or close the valve.

These indications show on the primary display system:

- Cabin altitude
- Cabin altitude rate of change
- Differential pressure
- Selected landing altitude
- Outflow valve positions
- System problems.

Differential pressure is the difference in pressure between the inside and outside of the airplane. The maximum pressure is 8.6 psi. The positive pressure relief valves open if the pressure inside the airplane is too high.

If the pressure outside the airplane is higher than the pressure inside, the negative pressure vents open.



1 This information shows only if the forward cargo A/C option is installed.

Air Synoptic Display

Synoptic Display

For the pneumatics system, the air synoptic display shows this information:

- Ground air in use
- Duct pressures
- Engine bleed air pressure regulating and shutoff valve position
- Isolation valve position
- APU shutoff valve position.

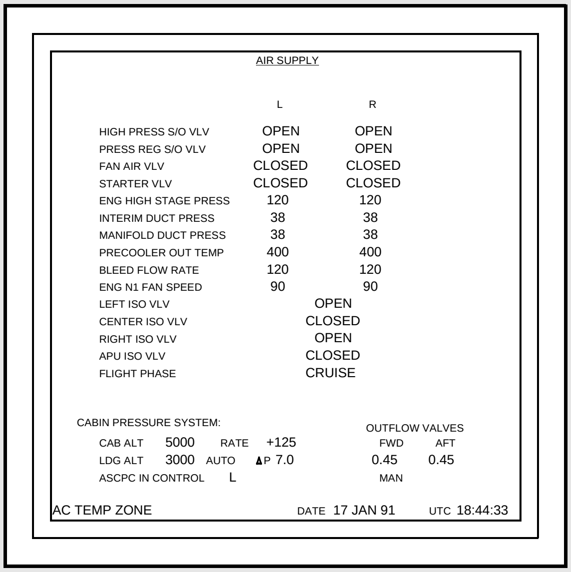
An X on an isolation valve symbol or the APU shutoff valve symbol shows the valve has failed or the switch on the bleed air/pressurization panel for the valve is in the non-normal position.

For the air conditioning system, the air synoptic display shows this information:

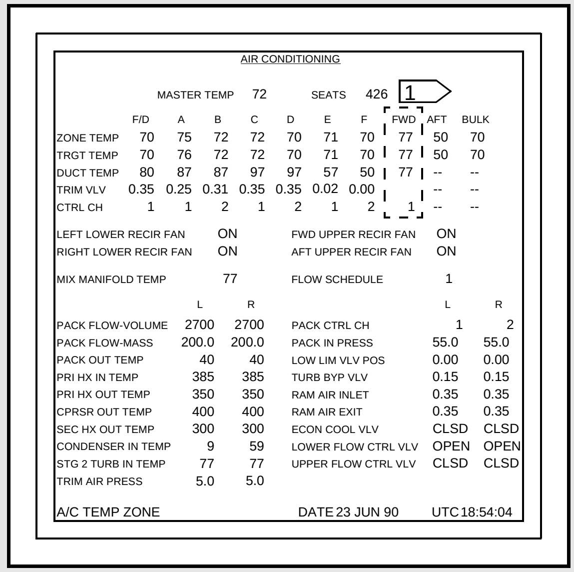
- Normal air conditioning pack operation
- Standby air conditioning pack operation
- Trim air pressure regulating and shutoff valve position
- Master air conditioning temperature for the whole airplane
- Target and actual temperature for each air conditioning zone
- Flight deck trim air modulating valve position
- Target and actual temperature in the cargo compartments.

The air synoptic display shows position data for these valves:

- APU start valve
- Engine start valves
- Engine thermal anti-ice valves
- Wing thermal anti-ice valves.



Air Supply Maintenance Page



Air Conditioning Maintenance Page

1 This information shows only if the forward cargo A/C option is installed.

Air Supply and Air Conditioning Maintenance Pages

Maintenance Pages

Environmental control system data is on two maintenance pages. The air supply maintenance page shows this information:

- Pneumatic system valve positions
- Pneumatic system pressures
- Pneumatic system temperatures
- Flight phase
- Cabin pressure system data
- Outflow valve position.

The air conditioning maintenance page shows this information:

- Zone temperatures
- Trim valve positions
- Recirculation fan conditions
- Pack data
- Pack flow schedule
- Pack flow
- Temperatures at points throughout the pack
- Pack valve positions.

Ice and Rain Protection

- **Anti-Ice**
- **Ice Detection**
- **Wing Anti-Ice**
- **Engine Anti-Ice**
- **Air Data Probe Heat**
- **Window Heat**
- **Windshield Rain Removal**
- **Water and Waste Heat**

Features

ICE DETECTION

Ice detectors are on the side of the forward fuselage. When the airplane is in the air and the detectors sense ice, they operate the engine and wing anti-ice systems.

WING ANTI-ICE

When the airplane is in the air, bleed air prevents ice on three of the five outboard leading-edge slats.

ENGINE ANTI-ICE

Bleed air from the engine prevents ice on the forward edge of the engine inlet cowl.

AIR DATA PROBE HEAT

Electric heaters heat these air data sensors:

- Three pitot probes
- Two angle-of-attack sensors
- One total air temperature probe
- Two engine inlet probes (P&W and R-R).

WINDOW HEAT

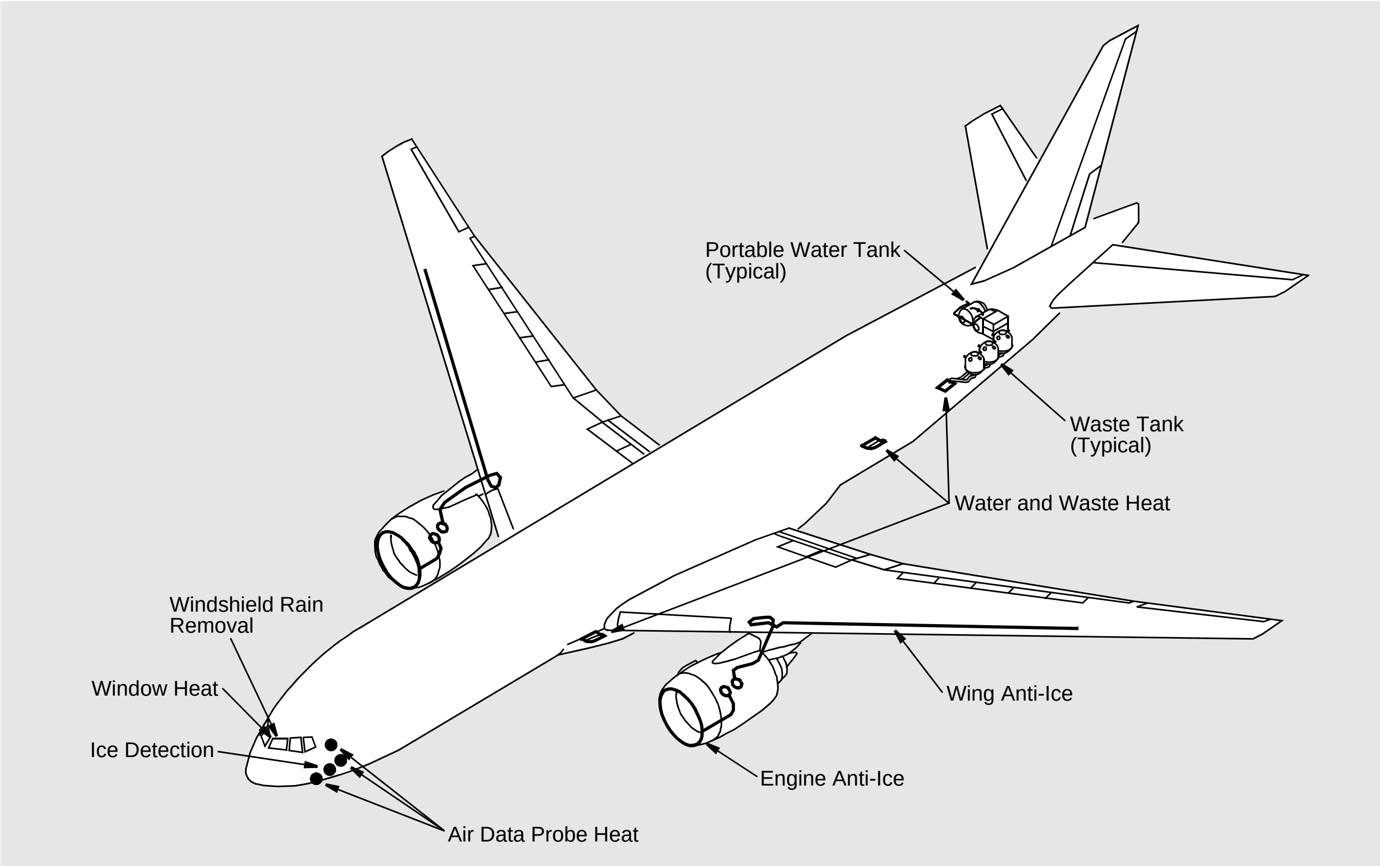
Electric heaters in the flight deck windows prevent fog and ice on the windows.

WINDSHIELD RAIN REMOVAL

A permanent coating on the forward flight deck windows repels water. Windshield wipers remove water.

WATER AND WASTE HEAT

Electric heaters prevent freezing in the water and waste systems.

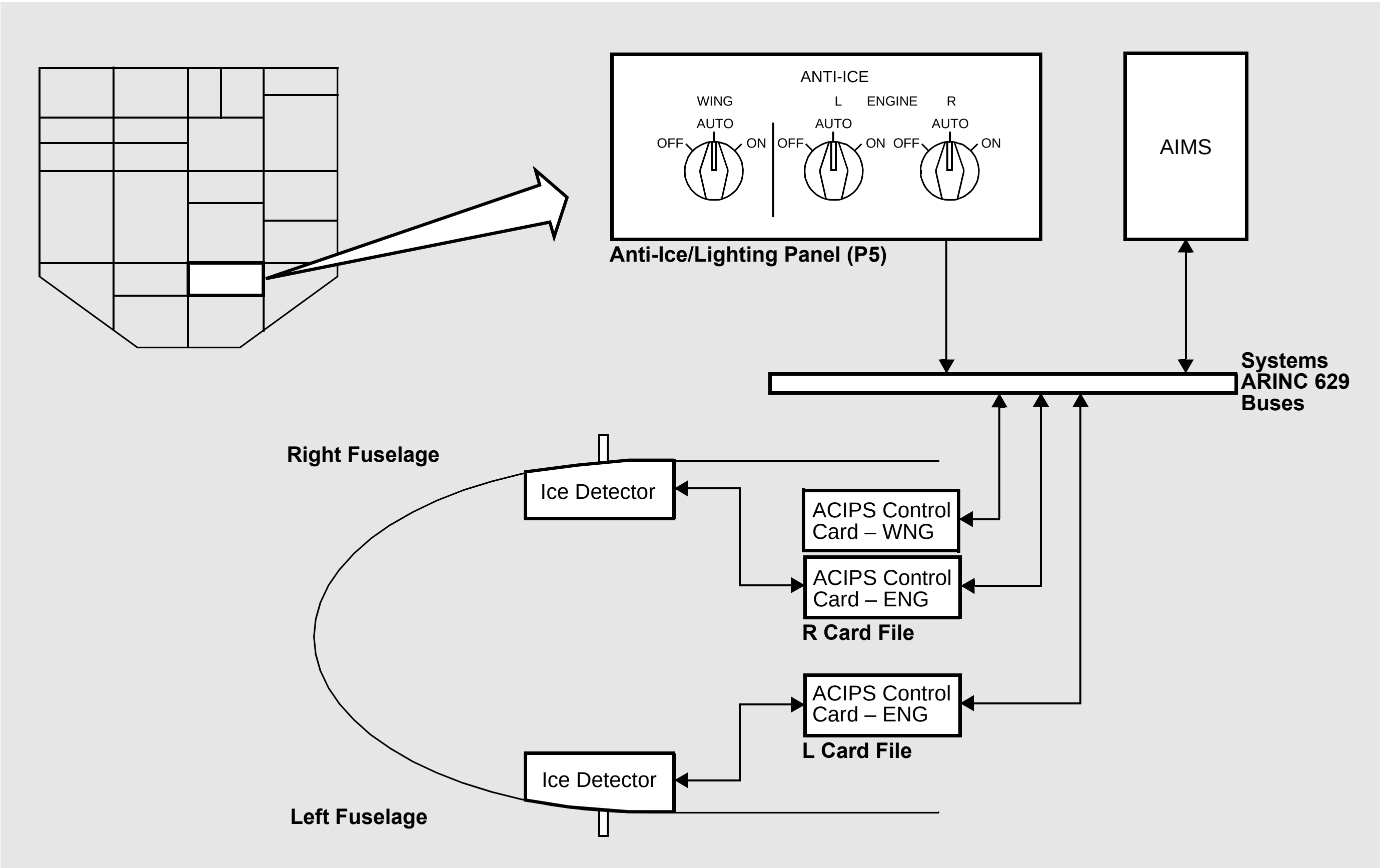


Anti-Ice Systems

Anti-Ice

The wings and engine inlet cowls have anti-ice systems that use bleed air. The ice detection system automatically operates these systems during icing conditions.

The flight deck windows, air data sensors, drain masts, and potable water lines have electric anti-icing systems.



Ice Detection System

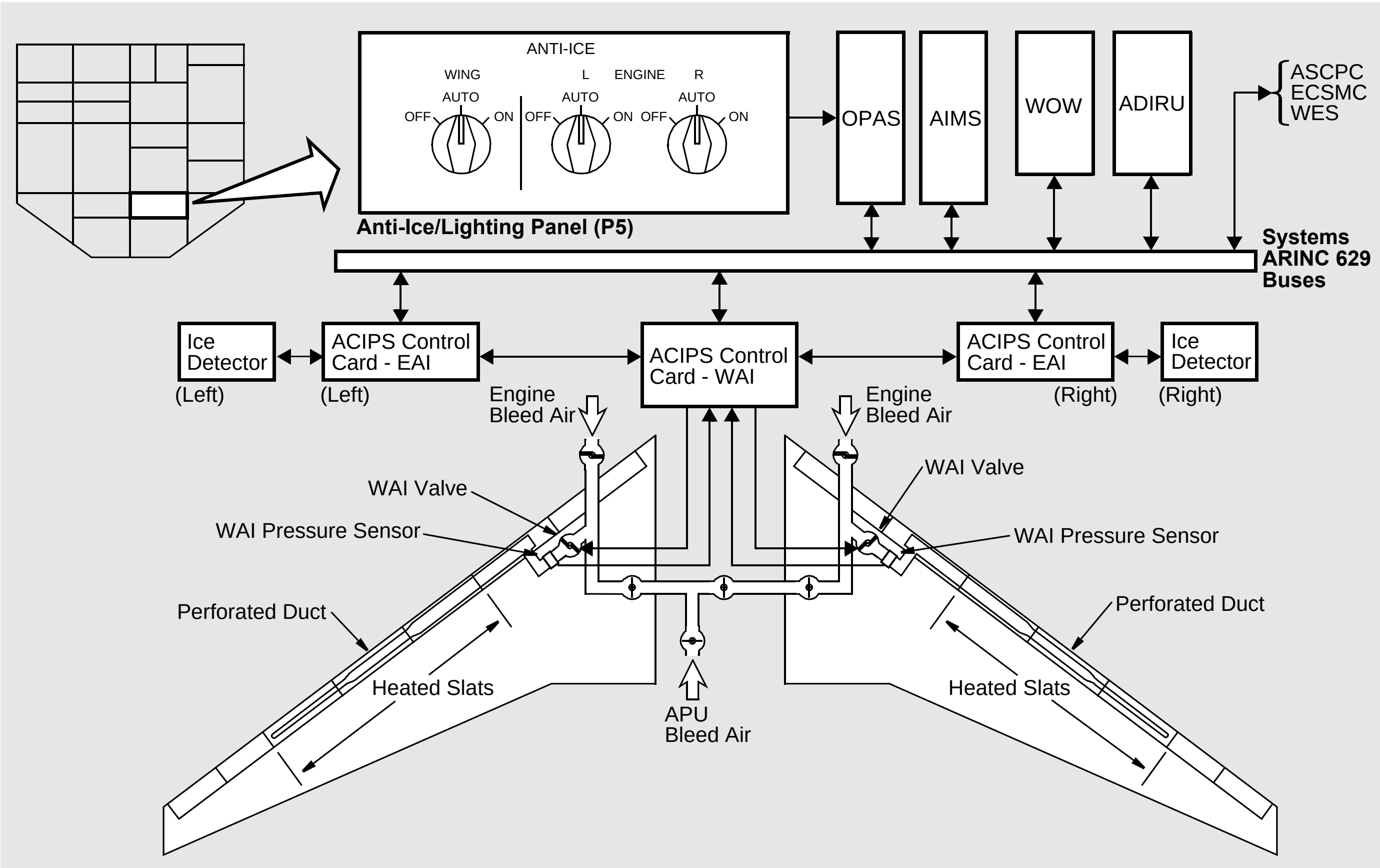
Ice Detection

The ice detection system has an ice detector on each side of the forward fuselage. When ice collects on either detector, a signal goes to the engine airfoil and cowl ice protection system (ACIPS) card.

The engine ACIPS cards share the information with the wing ACIPS card. The cards operates the wing and engine anti-ice systems automatically when the engine and wing switches are in auto and the airplane is in the air.

Also, an EICAS message shows for these conditions:

- A switch is in the OFF position and ice is detected
- A switch is in the ON position and no ice is detected.



Wing Anti-Ice System

Wing Anti-Ice

The wing anti-ice (WAI) system prevents ice on slats three, four, five, ten, eleven, and twelve. It uses air from the pneumatic system.

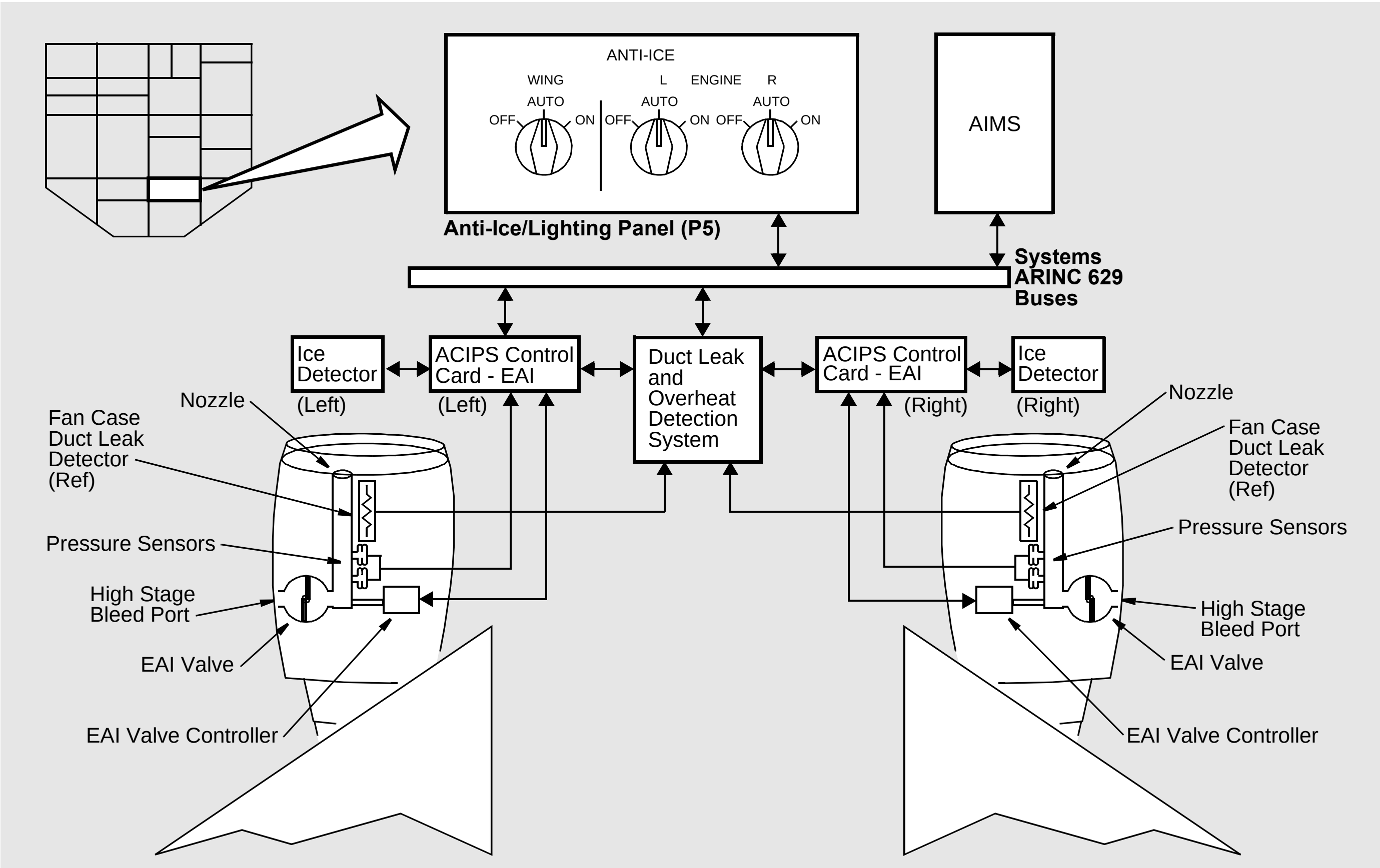
The ice detection system turns on the WAI system when all of these conditions occur:

- The airplane is in the air
- The selector is in auto
- Ice is detected.

The flight crew can also use the selector to turn the system on in the air.

The system has a wing anti-ice (WAI) valve and a pressure sensor inside the leading edge of each wing. The valve regulates pressure. A spray tube takes the hot air into the slats. The air goes through perforations in the tube to heat the slats. Then it goes overboard through vents in the bottom of the slats.

There are no test switches for the WAI system. The central maintenance computing system (CMCS) can do a test of the system with the airplane on the ground.



Engine Anti-Ice System

Engine Anti-Ice

The engine anti-ice (EAI) system uses air from a dedicated bleed port on the engine to prevent engine inlet cowl ice.

The ice detection system turns on the EAI system when all of these conditions occur:

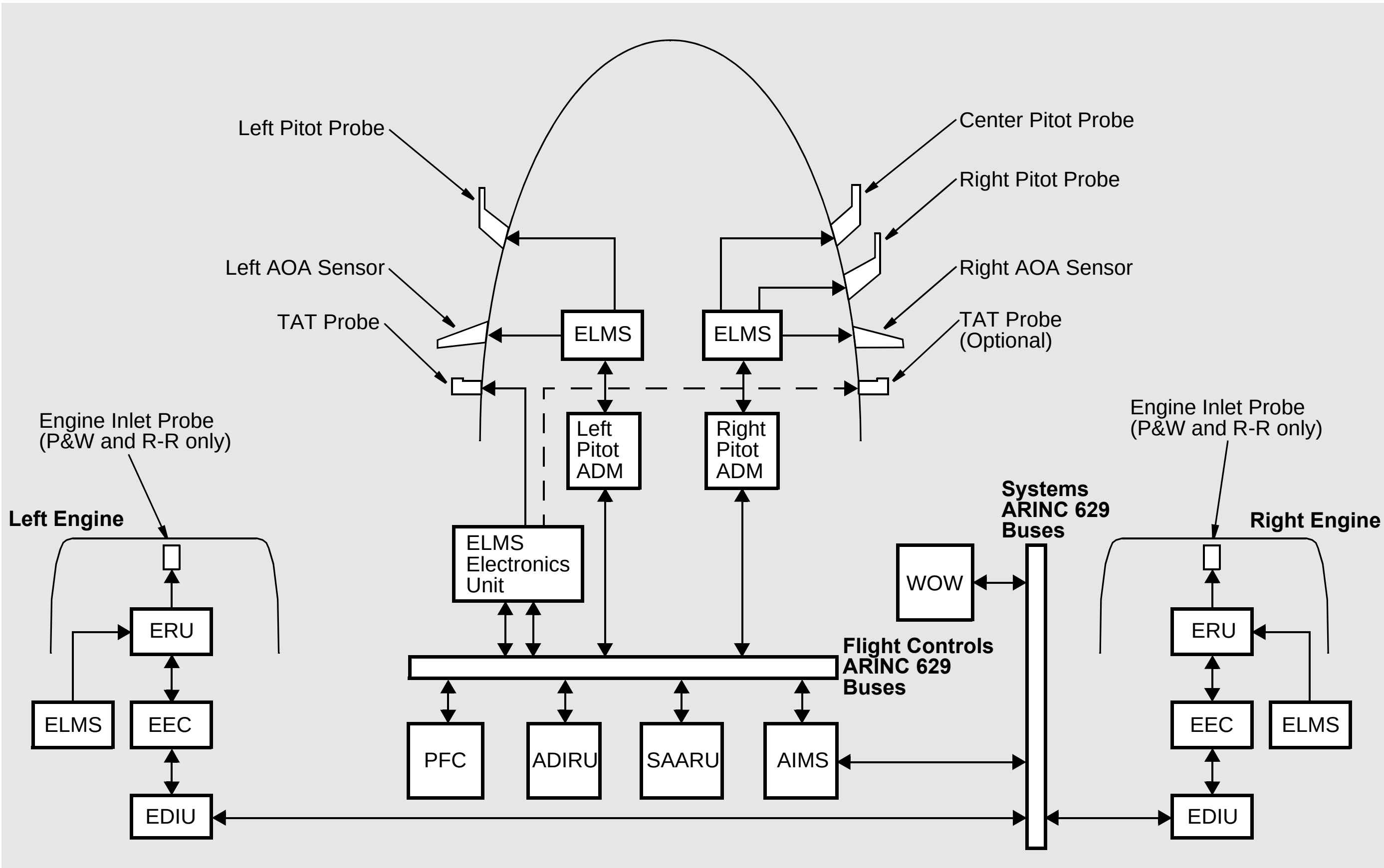
- The airplane is in the air
- The selector is in auto
- Ice is detected.

The flight crew can also use the selector to turn on the system on the ground or in the air.

Hot bleed air flows from the EAI valve, through a duct, and into the inside of the engine inlet cowl. The bleed air leaves the cowl through an overboard vent on the bottom of the cowl.

Two pressure sensors are in the EAI duct for each engine. The sensors give pressure information to the EAI ACIPS card to control the valve position.

There is an overheat detector adjacent to the EAI duct. When the detector senses a leak, the duct leak and overheat detection system (DLODS) sends a signal to the applicable ACIPS card. It closes the EAI valve.



Air Data Probe Heat System

Air Data Probe Heat

The air data probes have electric heaters. The air data modules and the electrical load management system (ELMS) control the heaters.

The pitot probes have two levels of heat. The angle of attack (AOA), total air temperature (TAT), and engine inlet probes have one level.

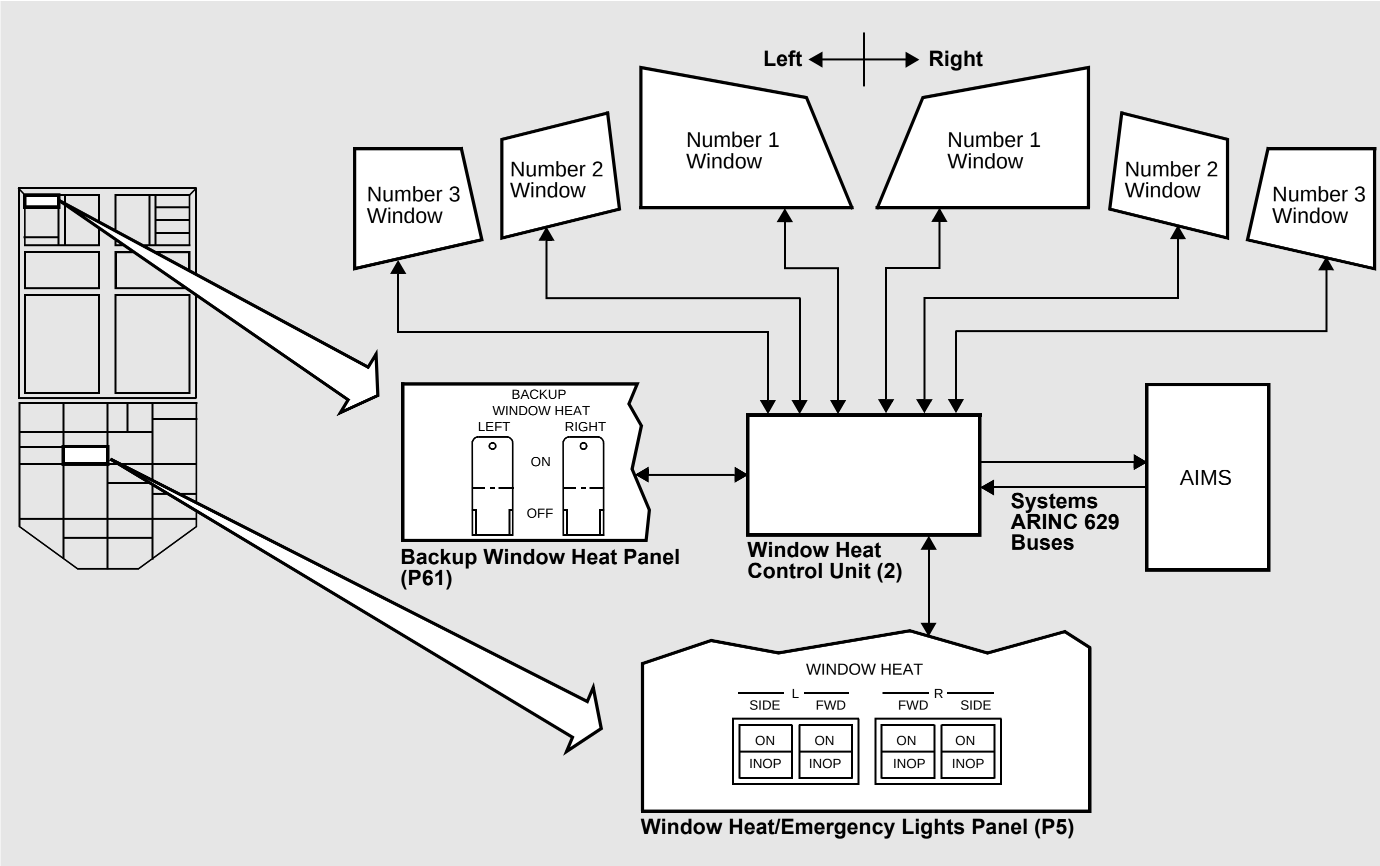
On the ground with both engines off, the heaters do not operate.

These are the conditions on the ground with an engine on:

- Pitot probes are on low heat
- AOA sensors are heated
- The engine inlet probes on each operating engine is heated.

These are the conditions during flight:

- Pitot probes are on high heat
- AOA sensors are heated
- TAT probes are heated
- The engine inlet probes are heated.



Window Heat System

Window Heat

The window heat system prevents ice and fog on the flight deck windows.

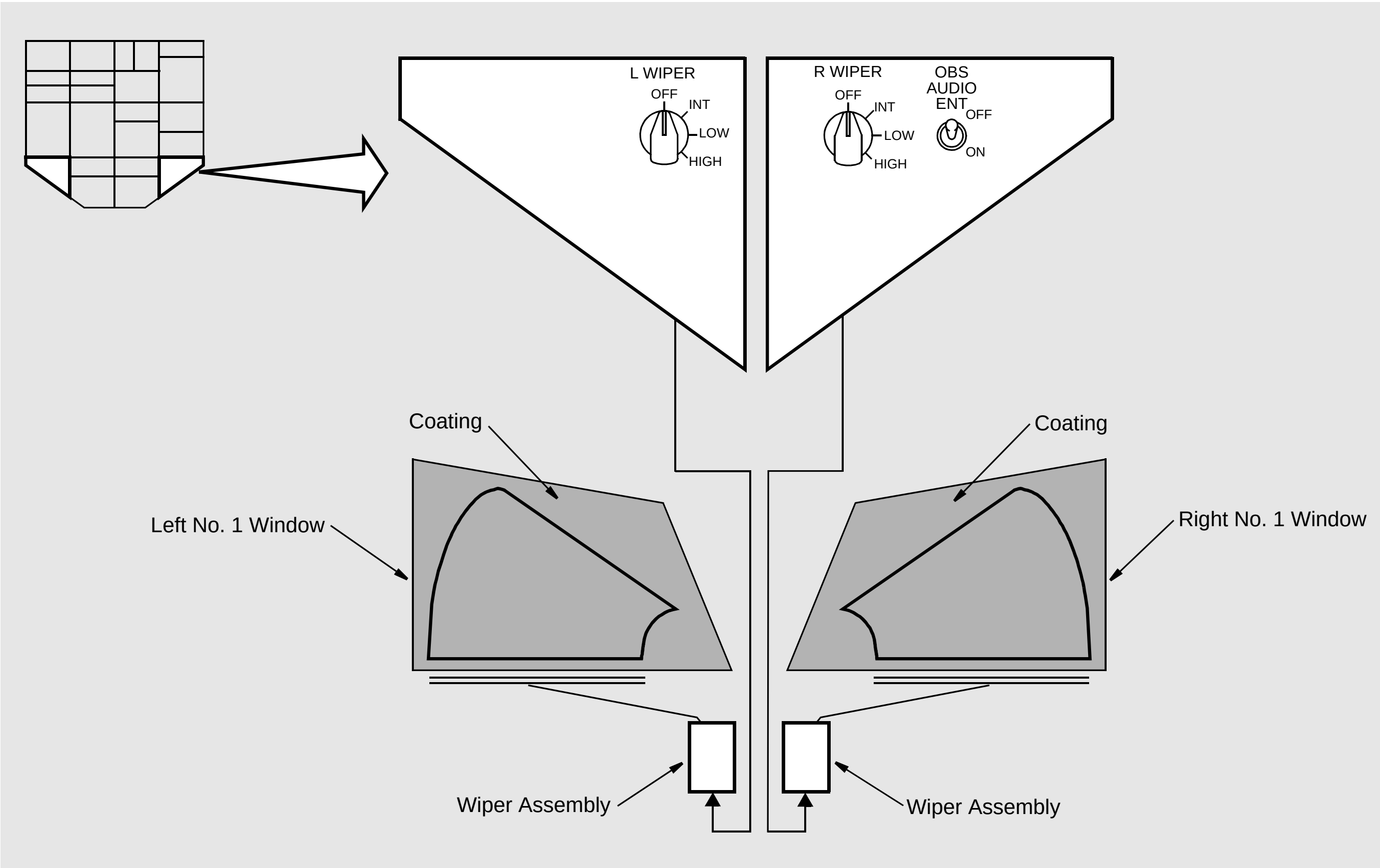
Electrically resistive material in the window lamination heats the windows. The heat layer for the number two and three windows is near the inside surface. It is for anti-fog. The number one window has two heat layers. The one near the inside surface is for anti-fog. The one near the outside surface is for anti-ice.

Two window heat control units (WHCUs) in the main equipment center control the system. One controls the power for the left number one window and the right number two and three windows. The other controls the power for the right number one window and the left number two and three windows. A backup heat circuit in the controllers gives power to the number one window anti-fog circuit.

The window heat switches are on the P5 overhead panel. The switches for the backup window heat system are on the P61 overhead maintenance panel. When the window heat switches are on, the controllers send power to the number one window anti-ice layer and the number two and three window anti-fog layer.

A controller sends power to the number one window anti-fog layer if the anti-ice heat fails or if the window heat switch is off. The backup window heat switch on the P61 lets maintenance personnel remove backup heat power.

The WHCUs reduce their power output to the number one windows during the first four minutes of operation. This reduces the thermal stress on the number one windows. The WHCUs contain an automatic shutoff circuit to protect the windows from overheat conditions.

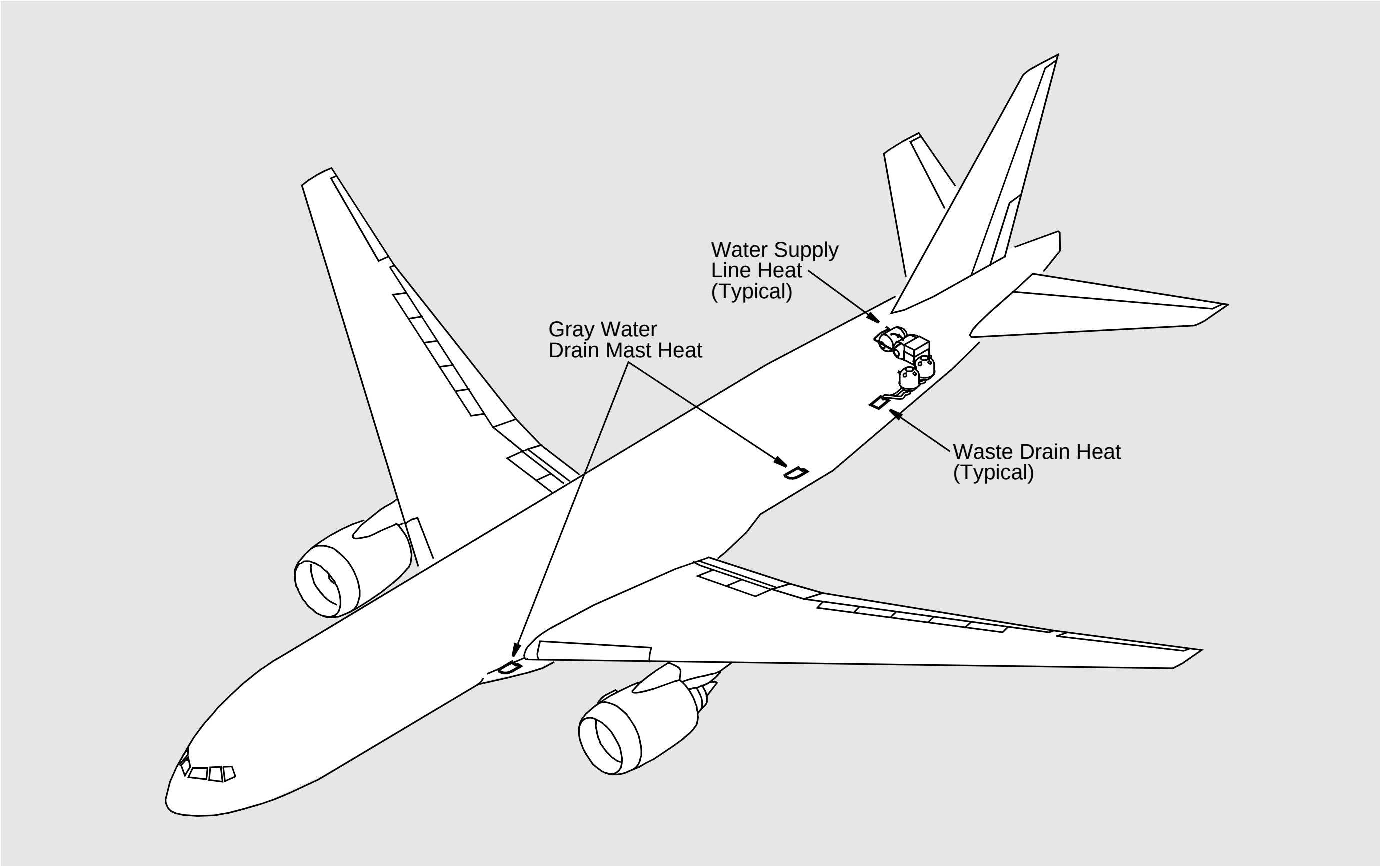


Windowshield Rain Removal System

Windshield Rain Removal

A coating on both number one windows repels rain. The window manufacturer applies the coating. The airplane operator can renew it.

Electrically powered windshield wipers remove water from the left and right number one windows. There is a selector on the P5 overhead panel for each wiper.



Water Supply Line, Gray Water Drain Mast, and Waste Drain Heat

Water and Waste Heat

Electrical heat sources prevent ice in the water and waste systems.

These components heat the water supply lines:

- Heater tape
- Inline heaters
- Heated hoses.

Heaters in the gray water drain masts give high heat in flight and low heat on the ground.

Heated gaskets protect the waste drains. Heater blankets heat the waste tank drain lines.

Features

FIRE AND OVERHEAT DETECTION SYSTEMS

Dual loop systems protect these areas:

- Engines
- APU
- Pneumatic ducts
- Wheel wells.

Detection circuits monitor these areas and cause flight deck indications.

Detectors on the engines monitor both fire and overheat conditions, they also supply temperature data to the airplane conditioning monitoring system.

Detection systems are automatically tested. They can also be manually tested.

Pneumatic and anti-ice system valves close automatically to isolate a leaking duct segment.

SMOKE DETECTION SYSTEMS

Cargo smoke detectors use light emitting diodes for high reliability. The smoke detectors can tell the difference between smoke and other aerosols.

A smoke detector in the optional lower lobe attendants rest (LLAR) operates similar to the cargo smoke detectors to monitor for smoke in the module (-200ER and -300).

FIRE EXTINGUISHING SYSTEMS

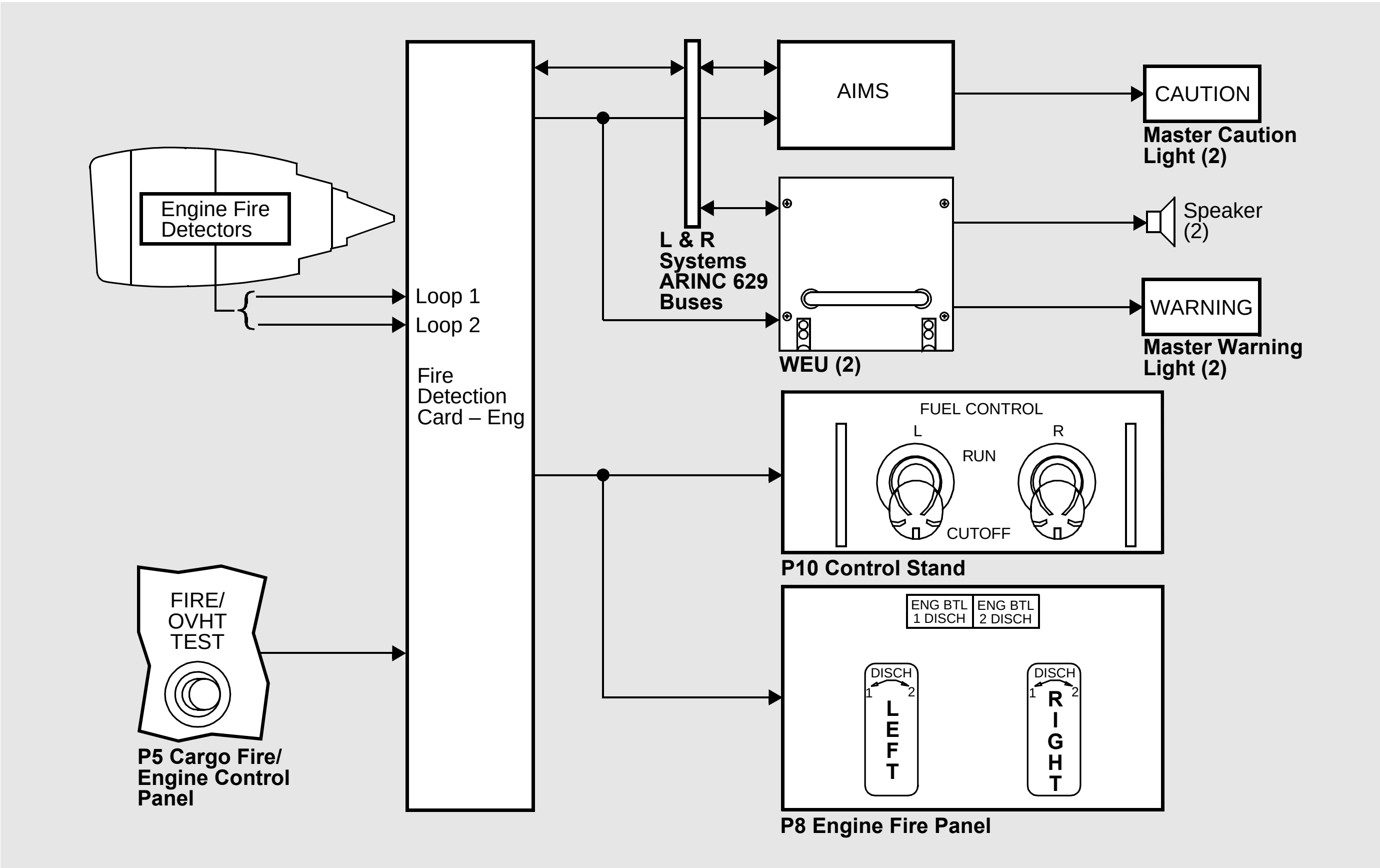
An APU fire on the ground when both engines are off automatically discharges the APU fire extinguisher.

The cargo fire extinguishing system uses flow valves to send the fire extinguishing agent to the forward or aft compartment. There are no multiple-bottle discharge outlets.

The fire extinguishing system in the LLAR sends the fire extinguishing agent to the common area inside the module (-200ER and -300).

The ELMS does an automatic squib test during each flight leg.

- **Engine Fire and Overheat Detection**
- **Engine Turbine Overheat Detection - Rolls-Royce**
- **Engine Fire Extinguishing**
- **APU Fire Detection**
- **APU Fire Extinguishing**
- **Cargo Compartment Smoke Detection**
- **Cargo Compartment Fire Extinguishing**
- **Wheel Well Fire Detection**
- **Duct Leak and Overheat Detection**
- **Lavatory Smoke Detection and Fire Extinguishing**
- **LLAR Smoke Detection (-200 ER and -300)**
- **LLAR Fire Extinguishing (-200 ER and -300)**



Engine Fire and Overheat Protection

Engine Fire And Overheat Detection

Each engine has three fire detectors in a dual loop system. The detectors monitor the engine for fire and overheat conditions. They also supply nacelle temperature data to the airplane condition monitoring system. Detector signals go to a fire detection card. The card sends signals for flight deck indications.

These are the engine fire indications:

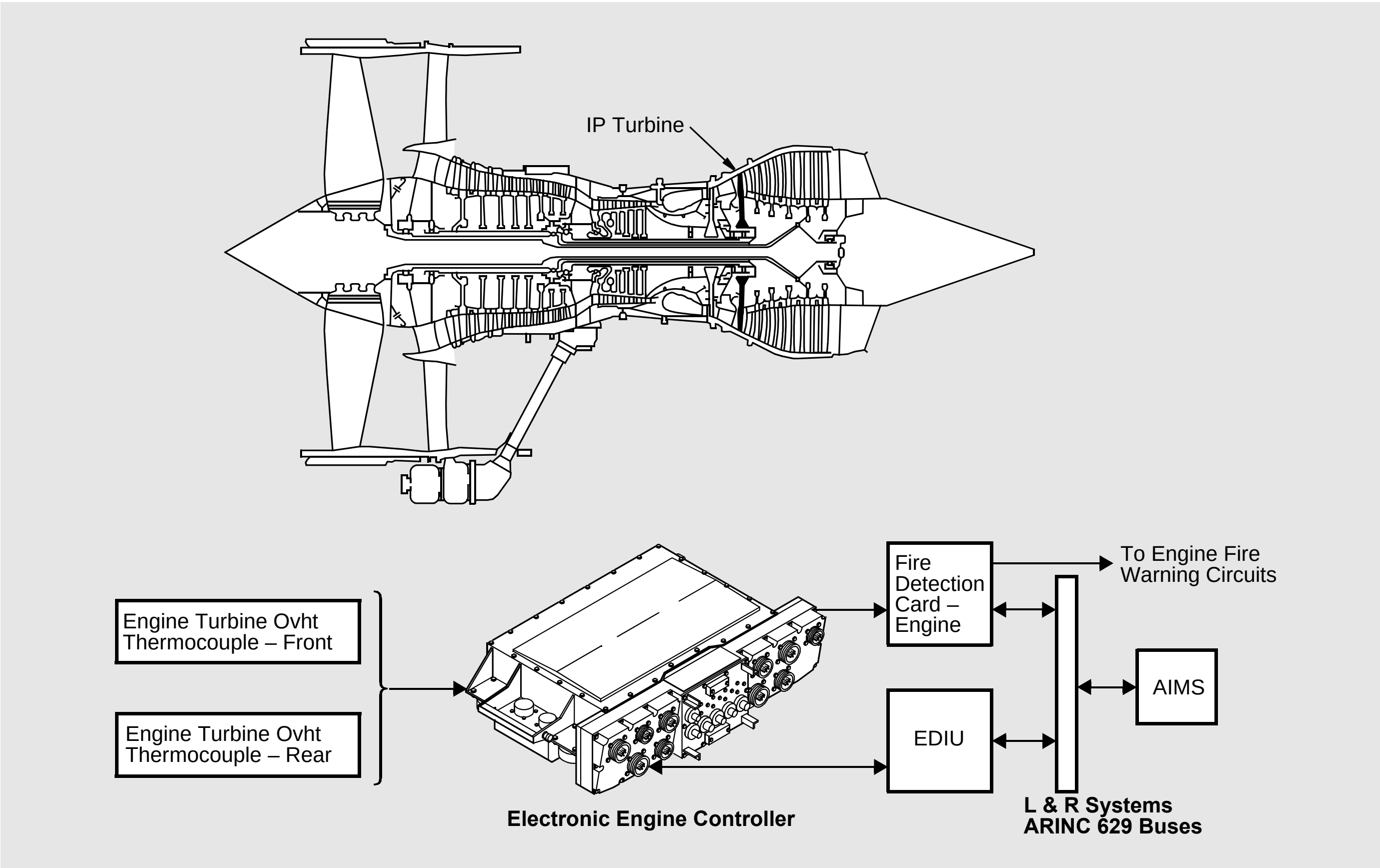
- EICAS warning message
- Fire warning aural
- Master warning lights
- Fuel control switch fire warning light
- Engine fire warning light.

These are the engine overheat indications:

- EICAS caution message
- Master caution lights
- Caution aural.

You use the fire/overheat test switch on the P5 to manually test the system. The test includes the engine fire indications. Test results show on the primary display system.

There are also periodic automatic tests. There are no indications from these tests unless there are faults.



Engine Turbine Overheat Protection — Rolls-Royce

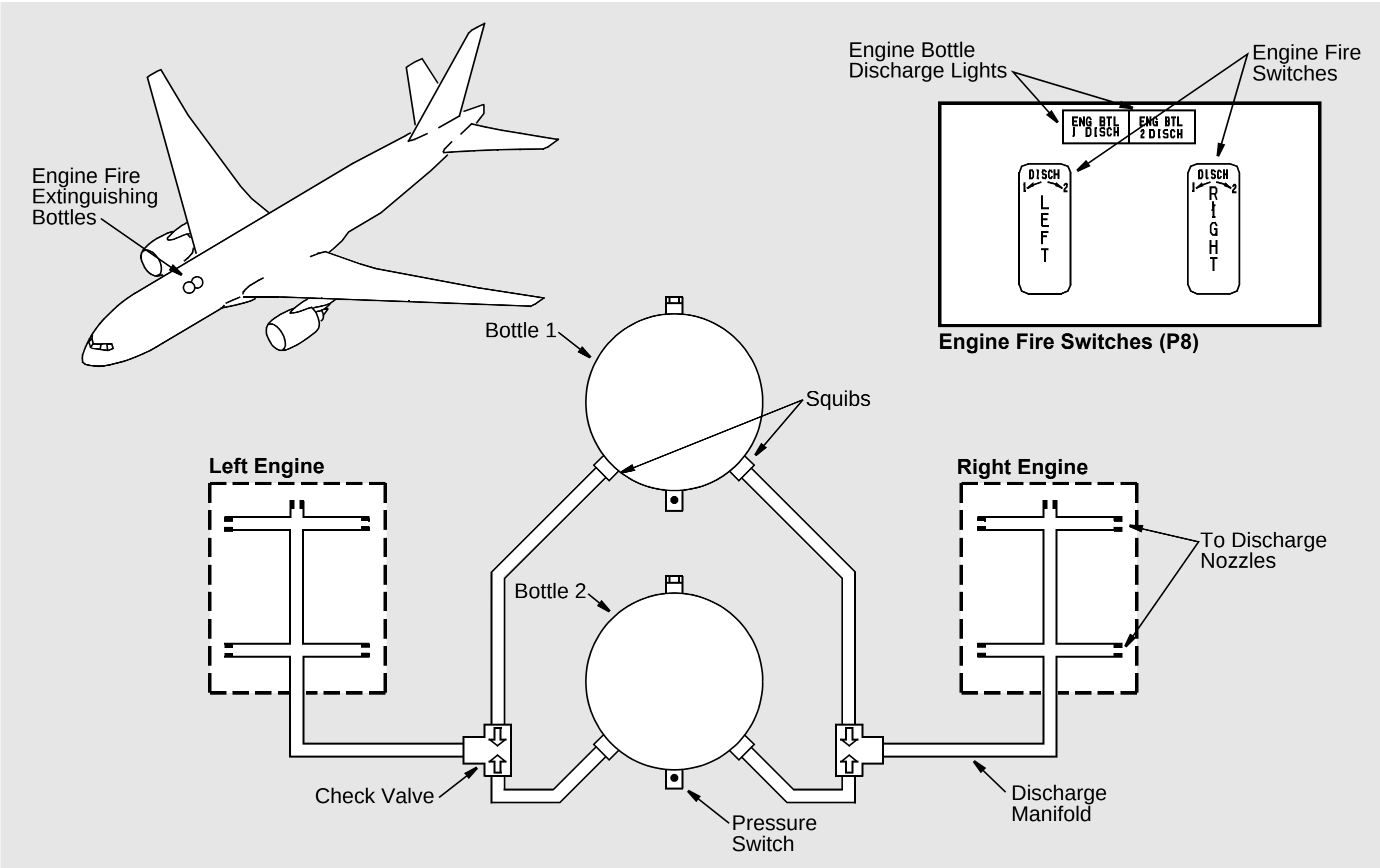
Engine Turbine Overheat Detection - Rolls-Royce

The engine turbine overheat detection system monitors the temperature of the cooling air at the front and rear of the intermediate pressure (IP) turbine. Engine fire warnings occur in the flight deck if the front or rear temperature is more than limits.

Two thermocouples give IP cooling air temperature information to the electronic engine controller (EEC). The EEC makes an analysis of the temperature information. If the EEC finds an overheat condition, it sends a signal to the engine fire detection card. The fire detection card turns on the engine fire warning indications in the flight deck.

BITE does a check of the condition of the system. Status and maintenance messages give information about system failures. The fire detection card monitors its interface with the EEC for failures and sends information about the failure to the AIMS. The EEC monitors the thermocouple circuits for failures. The EEC sends information about the failure through the engine data interface unit (EDIU) to the AIMS.

The FIRE/OVHT TEST switch in the flight deck does not do a test of this system.



Engine Fire Extinguishing

Engine Fire Extinguishing

The two engine fire extinguishing bottles are in the forward cargo compartment. They are aft of the cargo compartment door and outboard of the liner. They contain Halon. Each bottle has two discharge squibs. The squib is an electrically operated explosive device which breaks the seal on the discharge port. Pipes connect both bottles to discharge nozzles in each engine compartment.

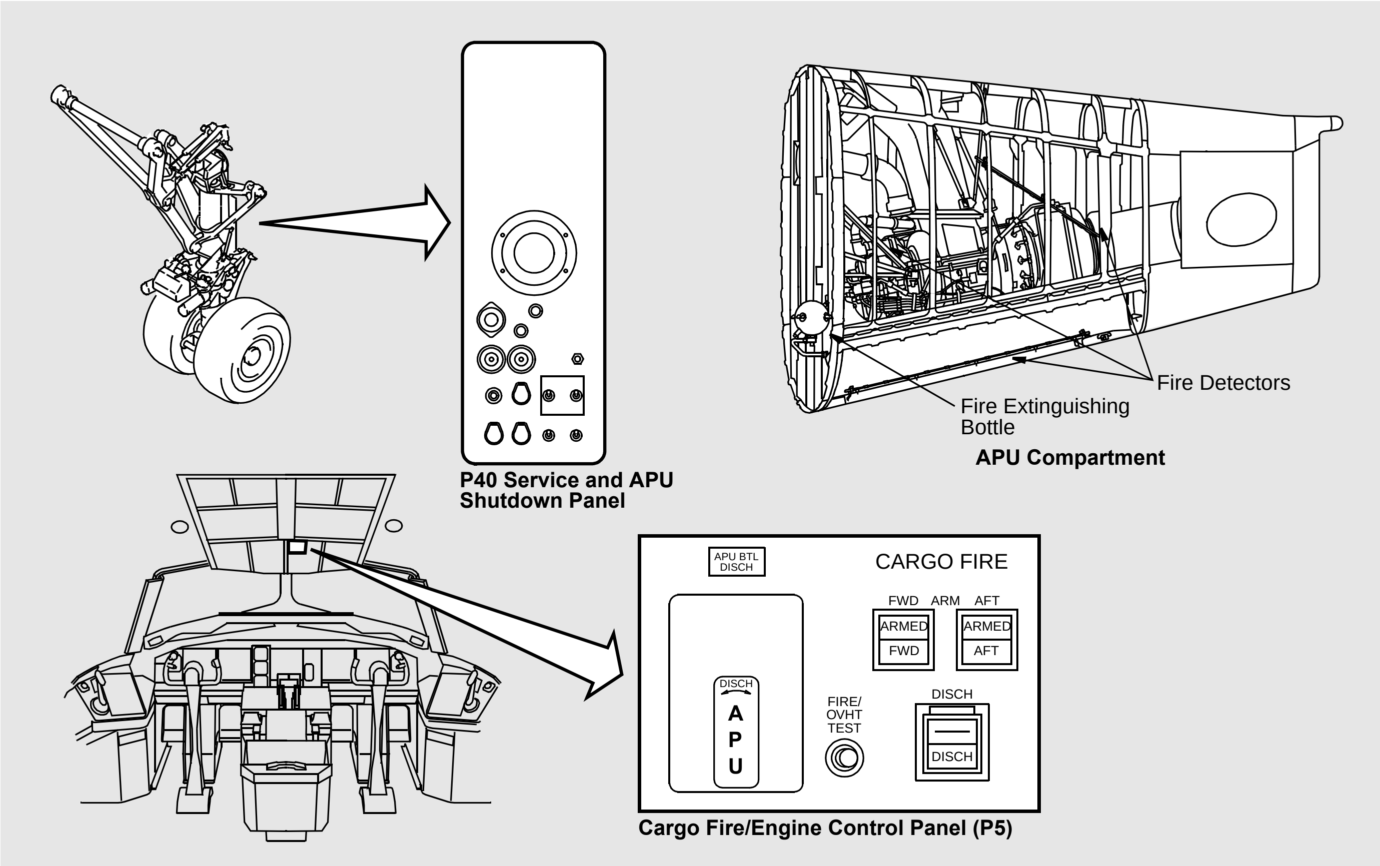
These things happen when you pull a fire switch:

- The squib arms
- Fuel supply to the engine stops
- Engine generators electrically disconnect
- Hydraulic fluid supply to the engine-driven pump stops
- Engine bleed air valves close
- Engine thrust reverser is deactivated.

When you turn a fire switch, the squib on one bottle fires and breaks the bottle seal. Halon discharges and flows to the selected engine. When you turn the switch in the other direction, the other bottle discharges to the same engine.

Discharge lights and the primary display system give indications of fire bottle discharge.

The ELMS does an automatic squib test during each flight leg. You can also use the MAT to do a squib test. Status messages show inoperative squib circuits.



APU Fire Detection and Extinguishing System

APU Fire Detection

There are three, dual loop fire detectors in the APU compartment.

These are the flight deck indications:

- APU shut down
- Master warning lights
- Fire warning aural
- EICAS warning message
- APU fire warning light.

These are the P40 service and APU shutdown panel indications:

- Red APU fire warning light
- Fire warning horn.

You use the fire/overheat test switch on the P5 to do a manual test of the system. The test includes the APU fire indications. Test results show on the primary display system.

There are also periodic automatic tests. There are no indications from these tests unless there are faults.

APU Fire Extinguishing

The APU fire extinguishing bottle is on the forward side of the APU compartment firewall. It contains Halon.

The system has automatic and manual bottle discharge. Automatic discharge occurs when:

- The airplane is on the ground
- The engines are off
- An APU fire is detected.

These things occur when you pull the APU fire switch (P5) or push the APU shutdown switch (P40):

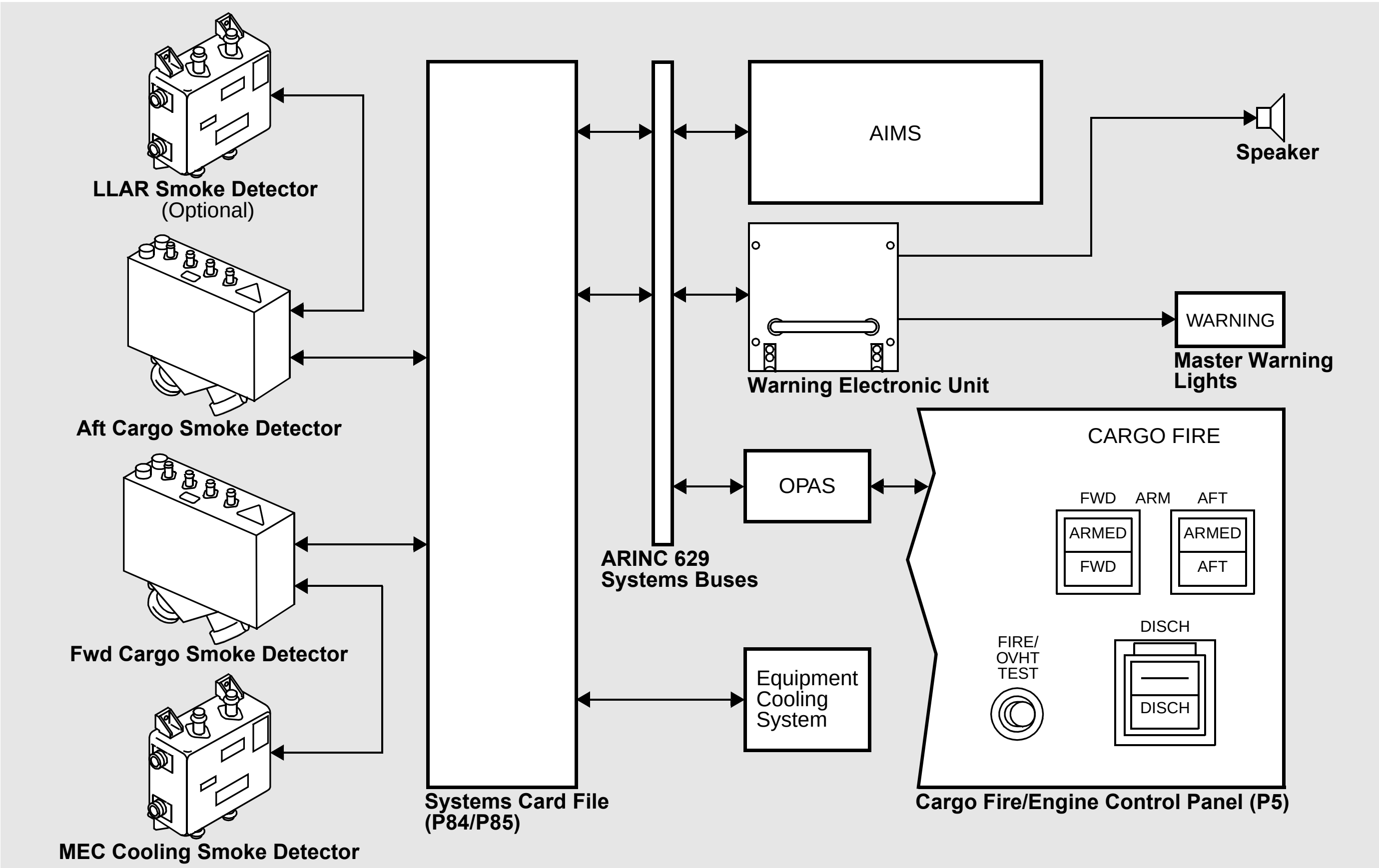
- The bottle squib arms
- The APU generator electrically disconnects
- The APU fuel shutoff valve closes
- The APU air shutoff valve closes
- The fire warning horn stops.

When you turn the APU fire switch on the P5 or push the bottle discharge switch on the P40 panel, the squib fires. Halon flows into the APU compartment.

These are the discharge indications:

- Discharge light on the cargo fire/engine control panel
- Primary display system messages
- Discharge light on the P40.

The ELMS does an automatic squib test during each flight leg. You can also use the MAT to do a squib test. Status messages show inoperative squib circuits.



Cargo Compartment Smoke Detection

Cargo Compartment Smoke Detection

The cargo smoke detection system (CSDS) monitors air in these areas for smoke:

- Forward cargo compartment
- Aft cargo compartment
- Bulk cargo compartment.

The forward cargo compartment smoke detector processes signals from the main equipment center (MEC) cooling smoke detector.

The aft cargo compartment smoke detector processes signals from the smoke detector in the optional LLAR (-200ER and -300).

These components make up the cargo smoke detection system:

- Light emitting diode smoke detectors
- Smoke detector fans
- Air sampling ducts.

The smoke detector fans bring air from the cargo compartments through the sampling ducts and into the smoke detectors. The smoke detectors analyze the air for smoke.

Cargo compartment smoke detection signals go to the ASG cards in the system card files. It sends signals to:

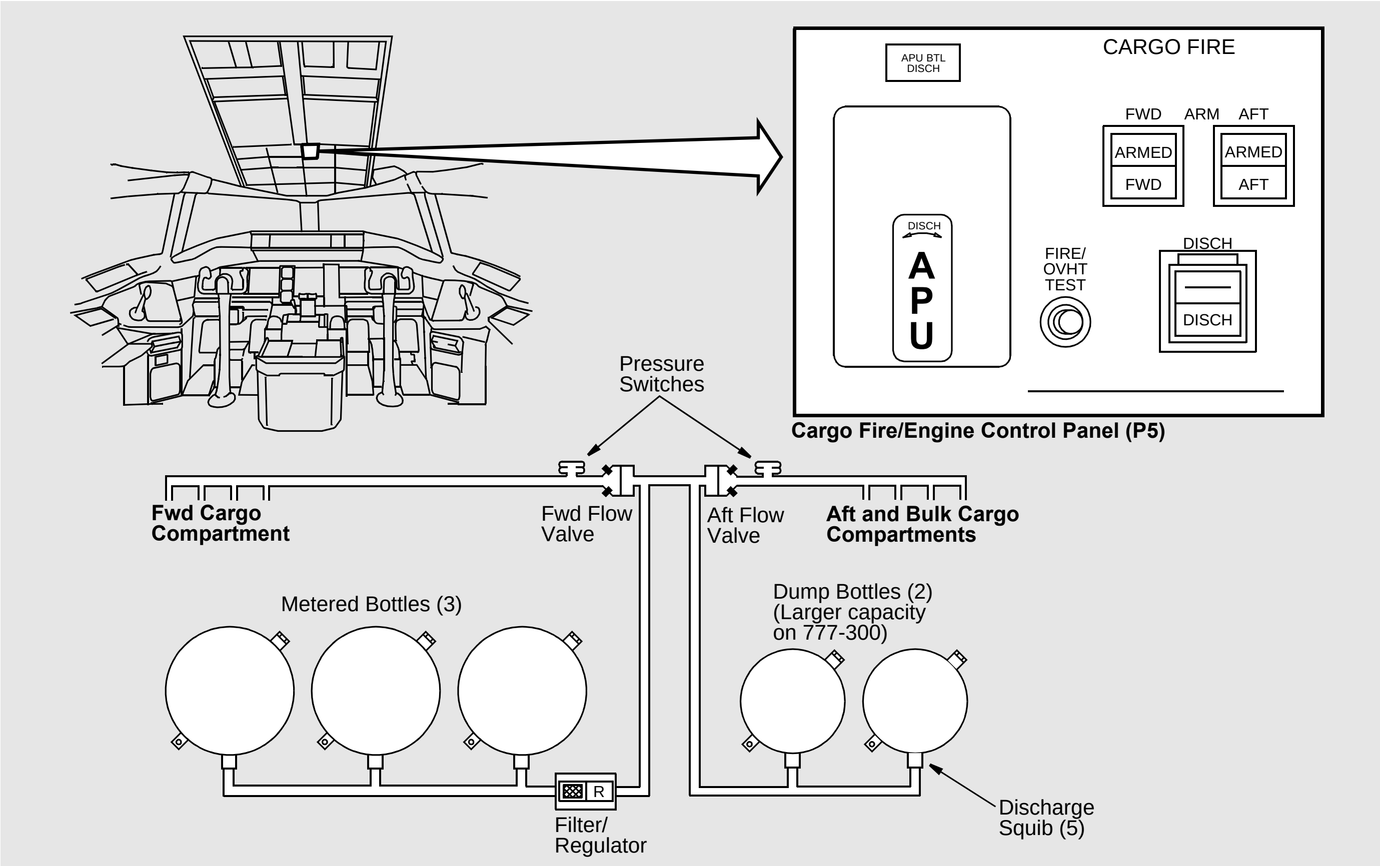
- OPAS
- WES
- AIMS.

These are the indications:

- EICAS warning message
- Fire warning aural
- Master warning lights
- Fwd or aft cargo fire warning light.

You use the fire/overheat test switch on the P5 to manually test the system. The test includes the cargo compartment fire indications. Test results show on the primary display system.

There are also periodic automatic tests. There are no indications from these tests unless there are system faults.



Cargo Compartment Fire Extinguishing System

Cargo Compartment Fire Extinguishing System

The cargo compartment fire extinguishing bottles are in the forward cargo compartment. They are aft of the cargo compartment door and outboard of the liner. The bottles are filled with Halon and pressurized with nitrogen. Tubes and flow valves connect the bottles to the forward, aft and bulk cargo compartments.

Each bottle has one discharge squib. Each flow valve has two squibs. The squib is an electrically-operated explosive device which breaks a seal in the bottle and in the flow valve. Halon flows from the bottle through the flow valve to the selected cargo compartment.

The cargo fire/engine control panel has forward and aft cargo fire arm switches and a discharge switch.

Push the forward or aft cargo fire arm switch to arm the system. Push the discharge switch to:

- Open the flow valve
- Release halon from the dump bottles
- Start a timer in ELMS for the discharge of the metered bottles.

This is how the metered bottles discharge:

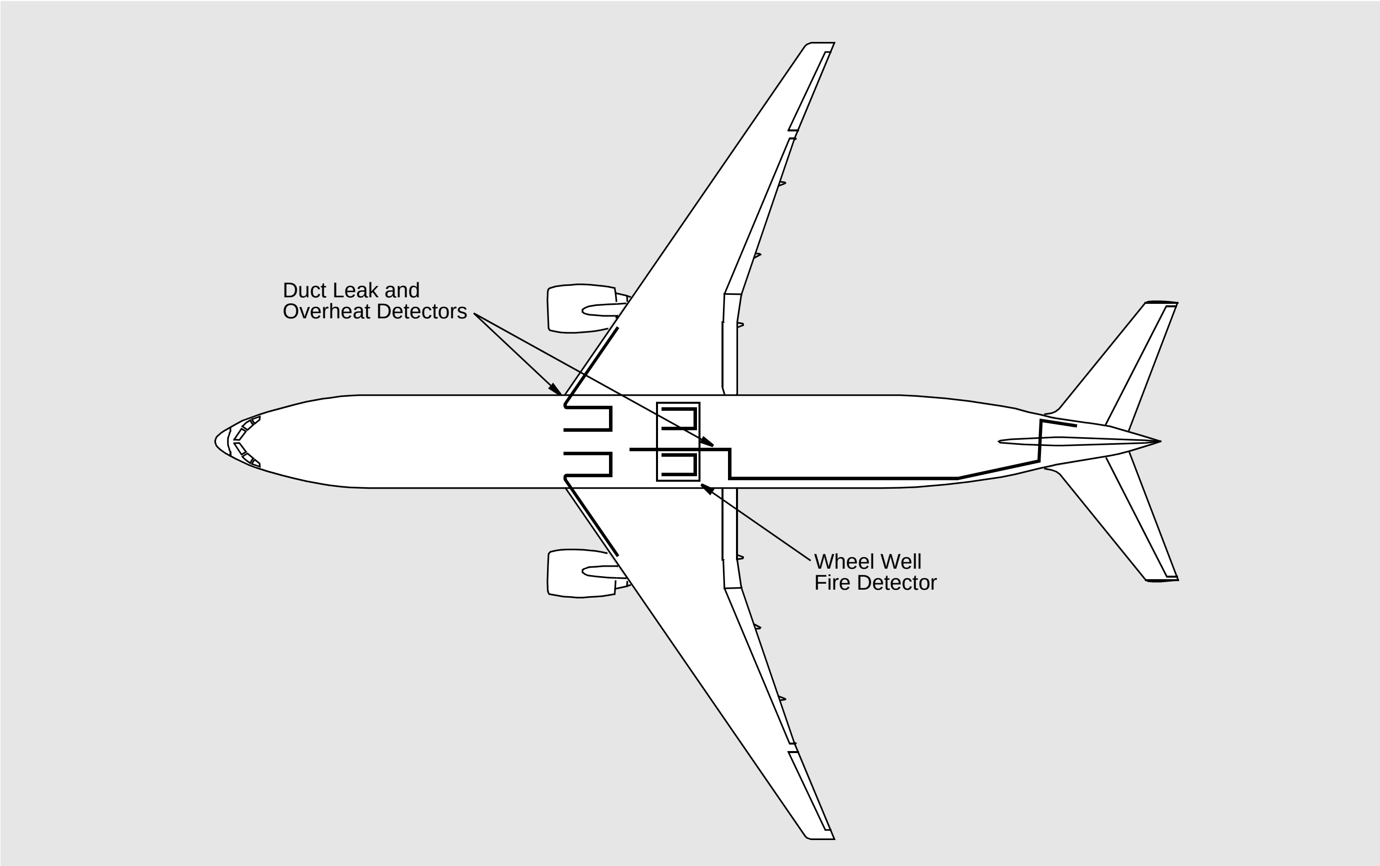
- If the airplane is on the ground when the discharge switch is set, one metered bottle will discharge 20 minutes after the dump bottles.
- If the airplane is in the air but lands less than 20 minutes after the switch is set, one metered bottle will discharge at landing.
- If the airplane is in the air 20 minutes after the switch is set, all of the metered bottles will discharge.

The filter/regulator causes the metered bottles to discharge slowly for long-term fire suppression.

It takes 180 minutes for all three bottles to completely discharge (240 minutes is an option).

A pressure switch in the discharge line turns on the light in the discharge switch. A pressure switch in each bottle shows bottle discharge on the primary display system. The primary display system also shows the condition of the squibs.

The ELMS does an automatic squib test during each flight leg. You can also use the MAT to do a squib test. Status messages show inoperative squib circuits.



Wheel Well, Duct Leak, and Overheat Detection Systems

Wheel Well Fire Detection

Dual loop fire detectors monitor the main wheel wells for brake and tire fires. There is a detector in each wheel well. These are the fire indications:

- EICAS warning message
- Master warning lights
- Fire warning aural.

You use the fire/overheat test switch on the P5 to do a manual test of the system. The test includes the wheel well fire indications. Test results show on the primary display system.

There are also periodic automatic tests. There are no indications from these tests unless there are system faults.

Duct Leak and Overheat Detection

The duct leak and overheat detection system (DLODS) is a dual loop system. The detectors parallel the high pressure ducts. These are the detectors:

- Two detectors in each engine strut
- Five detectors on the wing ducts
- Twelve detectors on the body ducts.

Some duct leaks are automatically isolated. A fan case overheat causes the engine anti-ice valve to close. Strut, wing, or body duct leaks cause pneumatic system valves to close.

There is continuous monitoring of the system. The fire/overheat test switch on the P5 does not test the system.

Lavatory Smoke Detection and Fire Extinguishing

Each lavatory has a smoke detector. Visual and aural indications occur in the lavatory and at attendant stations.

A Halon fire extinguisher is in the sink cabinet of each lavatory. Heat from a waste compartment fire causes the extinguisher to discharge.

Features

PASSENGER COMPARTMENT EQUIPMENT AND FURNISHINGS

The passenger compartment equipment and furnishings give comfort, convenience, and safety to the passengers and crew.

Interior design and flexibility let the airline select and rearrange the configuration to meet their needs.

LOWER LOBE ATTENDANTS REST

An optional lower lobe attendants rest (LLAR) is in the forward end of the aft cargo compartment. The LLAR contains equipment and furnishings for attendants. There is an entrance enclosure in the passenger compartment for access to the LLAR (-200ER and -300).

OVERHEAD FLIGHT CREW AND ATTENDANT REST

An optional overhead flight crew and attendants rest are in the overhead of the main cabin. The crew rests contain equipment and furnishings for the flight crews and attendants.

OXYGEN SYSTEMS

The flight deck crew gets oxygen from cylinder(s).

All passenger seats, attendant seats, and lavatories get oxygen from chemical generators.

Passenger oxygen from cylinders is an option.

POTABLE WATER

There are two potable water storage tanks on the 777-200. There are three tanks on the 777-200ER and the 777-300. Each tank has a capacity of 109 gallons.

LAVATORIES

The ability to change the configuration of the vacuum waste system gives more cabin interior flexibility. The vacuum toilets reduce odors and improve resistance to structural corrosion.

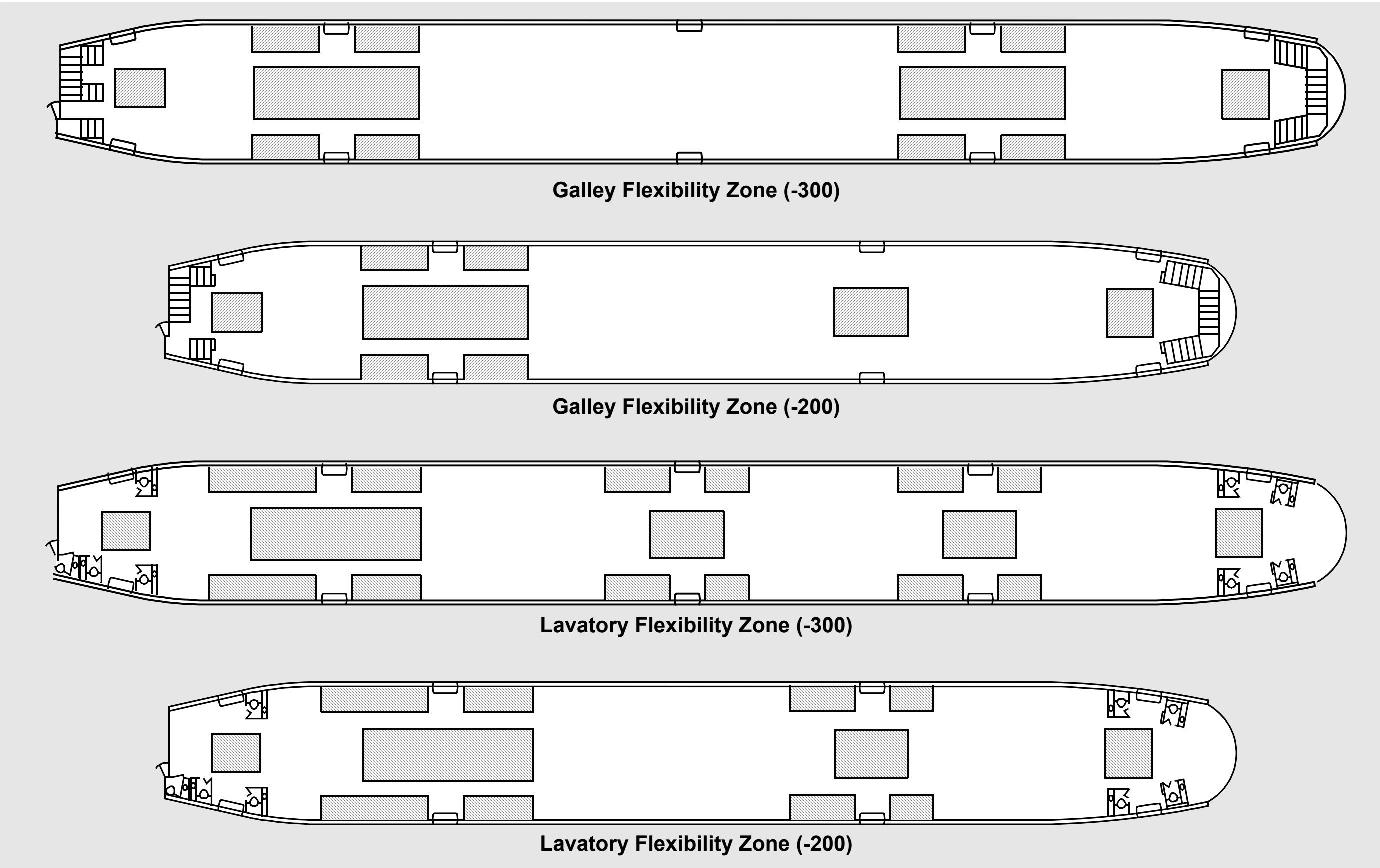
DOORS

Passenger entry door openings are wide enough for two people.

A large cargo door is standard on the forward cargo compartment and optional on the aft.

The large door permits the loading of pallet size cargo.

- **Passenger Compartment Equipment and Furnishings**
- **Lower Lobe Attendants Rest**
- **Overhead Flight Crew and Attendant Rest**
- **Overhead Stowage Bins**
- **Flight Crew Oxygen**
- **Passenger Oxygen**
- **Potable and Gray Water**
- **Lavatory Waste System**
- **Doors**
- **Windows**



Interior Flexibility

Passenger Compartment Equipment and Furnishings

INTERIOR CONFIGURATION

The airline specifies the airplane interior configuration.

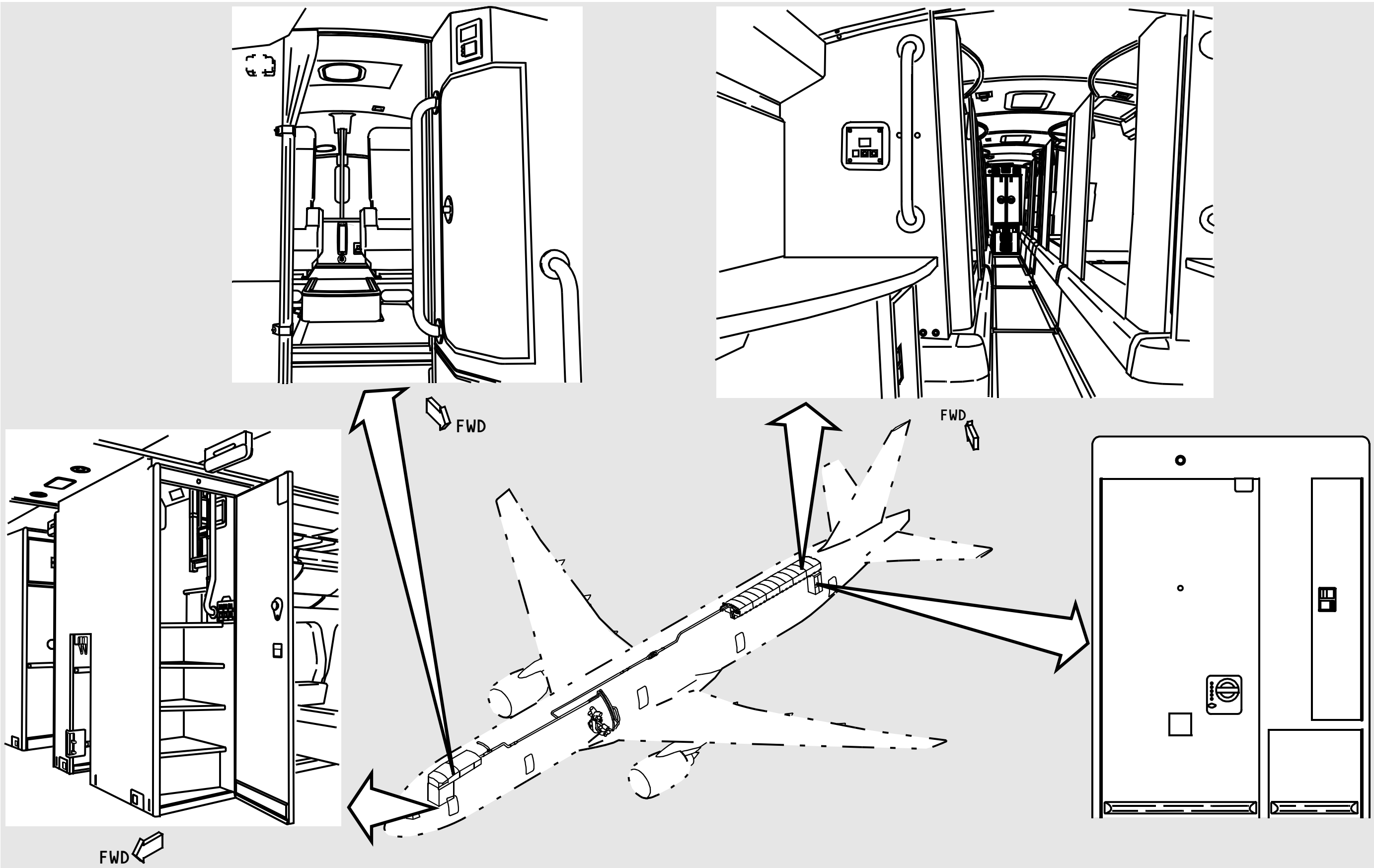
INTERIOR FLEXIBILITY

Interior flexibility zones are the areas in the airplane for the location of movable lavatories and galleys. The airline can move the lavatories and galleys to any position within these areas. Additional connections for plumbing, wiring, and air ducts are already installed.

The flexibility allows for changes in passenger loads and route structures.

These functions also have flexibility zones:

- Stowage bins
- Closet
- Class dividers/partitions
- LCD monitors
- Projection screens
- Video projectors
- Passenger service units
- Passenger entertainment
- Purser stations.



777-300 Overhead Flight Crew and Attendant Rest

777-300 Overhead Flight Crew and Attendant Rest

OVERHEAD FLIGHT CREW REST

The overhead flight crew rest (OFCR) contains two seats and two bunks for two crew members and a storage compartment for their belongings. The OFCR module has these functions:

- Ventilation and heating
- Fire detection
- Aural and visual fire/smoke indication
- Cabin interphone
- Passenger address
- Lighting
- Attendant call
- Supplemental oxygen.

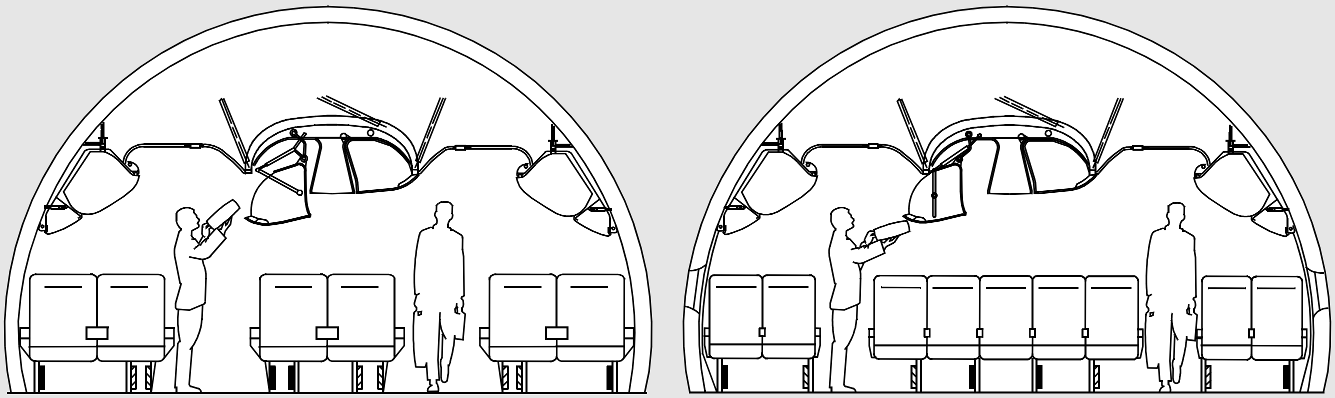
Access to the overhead flight crew rest (OFCR) module is in the main cabin area by door 1 left. You must open the entrance enclosure door and climb the stairs to the seat area. The bunks are aft of the seats.

OVERHEAD FLIGHT ATTENDANT REST

The overhead flight attendant rest (OFAR) contains a common area and four modules with two bunks in each module and two storage areas for attendant belongings. The OFAR module has these functions:

- Ventilation and heating
- Fire detection
- Aural and visual fire/smoke indication
- Cabin interphone
- Passenger address
- Lighting
- Attendant call
- Supplemental oxygen.

Access to the flight attendant rest module is in the main cabin area by door 5 left side. You must open the entrance enclosure door and go up the stairs into the common area. The bunks are forward of the common area.

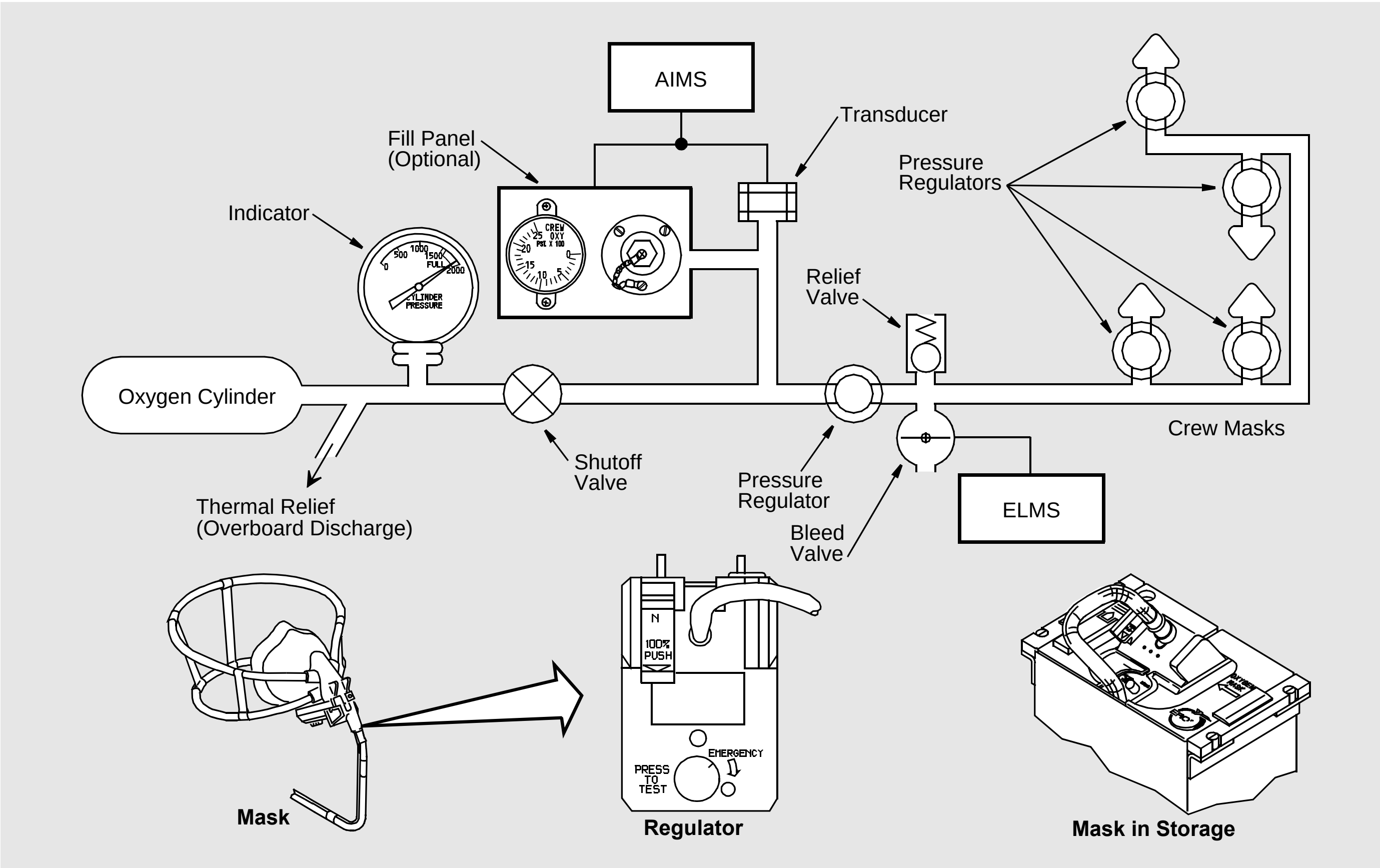


Overhead Stowage Bins

Overhead Stowage Bins

There are overhead stowage bins for carry-on items. They are above the outboard and center seats.

The center stowage bins move downward for easier use by the passengers. In higher density seating areas, they also move outboard toward the aisle.



Flight Crew Oxygen System

Flight Crew Oxygen System

A high pressure oxygen cylinder supplies oxygen to the fight crew. The cylinder is on the left side of the main equipment center.

A pressure regulator on the oxygen cylinder decreases the pressure to the flight deck to 60 to 85 psig. A second pressure regulator on the crew mask also makes sure the pressure is not more than 60 to 85 psig.

CONTROL AND INDICATIONS

There is a pressure gage on the cylinder. There is a pressure transducer on the supply line that goes to the flight deck. The pressure transducer sends a signal to the optional fill panel and to the AIMS for the primary display system.

The bleed valve opens for 15 seconds when the first engine starts. If the cylinder shutoff valve is not open, oxygen does not pressurize the supply line. The flight crew will see the low pressure on the status display.

CREW OXYGEN MASK STOWAGE

The oxygen mask and regulator are in a stowage box at each crew position. A valve in the box controls the oxygen flow to the mask. The box door opens the valve when the door is opened. You use a reset control on the box to close the valve after you close the door.

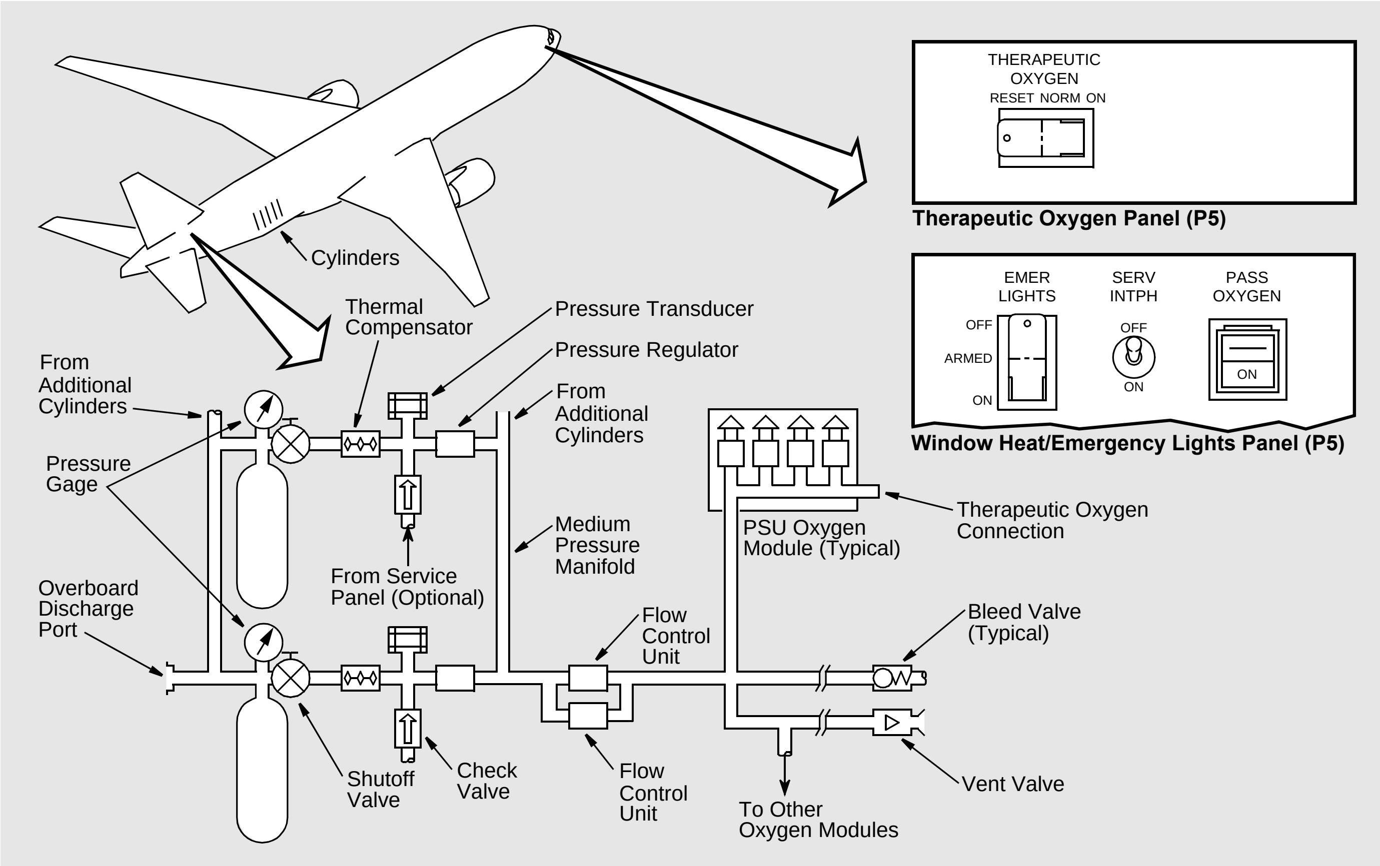
PNEUMATIC HARNESS

A pneumatic harness holds the mask to the user's face. A lever on the mask controls the inflation of the mask harness.

The user holds the control and puts on the mask with the harness inflated. The user releases the lever and the harness deflates. Elastic in the harness holds the mask to the users face.

REGULATOR CONTROLS

Oxygen flows into the mask when the user breathes. Controls on the mask lets the user set the oxygen to normal (diluted oxygen on demand), 100 percent (100 percent oxygen on demand), or emergency flow (continuous oxygen). The flow indicator on the stowage box shows the flow to the mask.



Gaseous Oxygen System (Optional)

Gaseous Oxygen System (Optional)

Gas cylinders supply oxygen in the optional system. The cylinders are on the right side of the aft cargo compartment.

There can be as many as 23 cylinders. The airline selects the number of cylinders (-200).

There can be as many as 25 cylinders. The airline selects the number of cylinders (-200ER and -300).

Cylinder pressure and gage transducers measure the cylinder pressures. The transducer sends a signal to the voltage averaging unit (VAU). The VAU sends a signal to the fill panel gage (optional) and to the primary display system.

A pressure regulator on the oxygen cylinders keep the pressure to the flow control unit at 600 - 700 psi.

These things happen by a switch on the P5 overhead panel or if the cabin altitude is 13,500 feet or more:

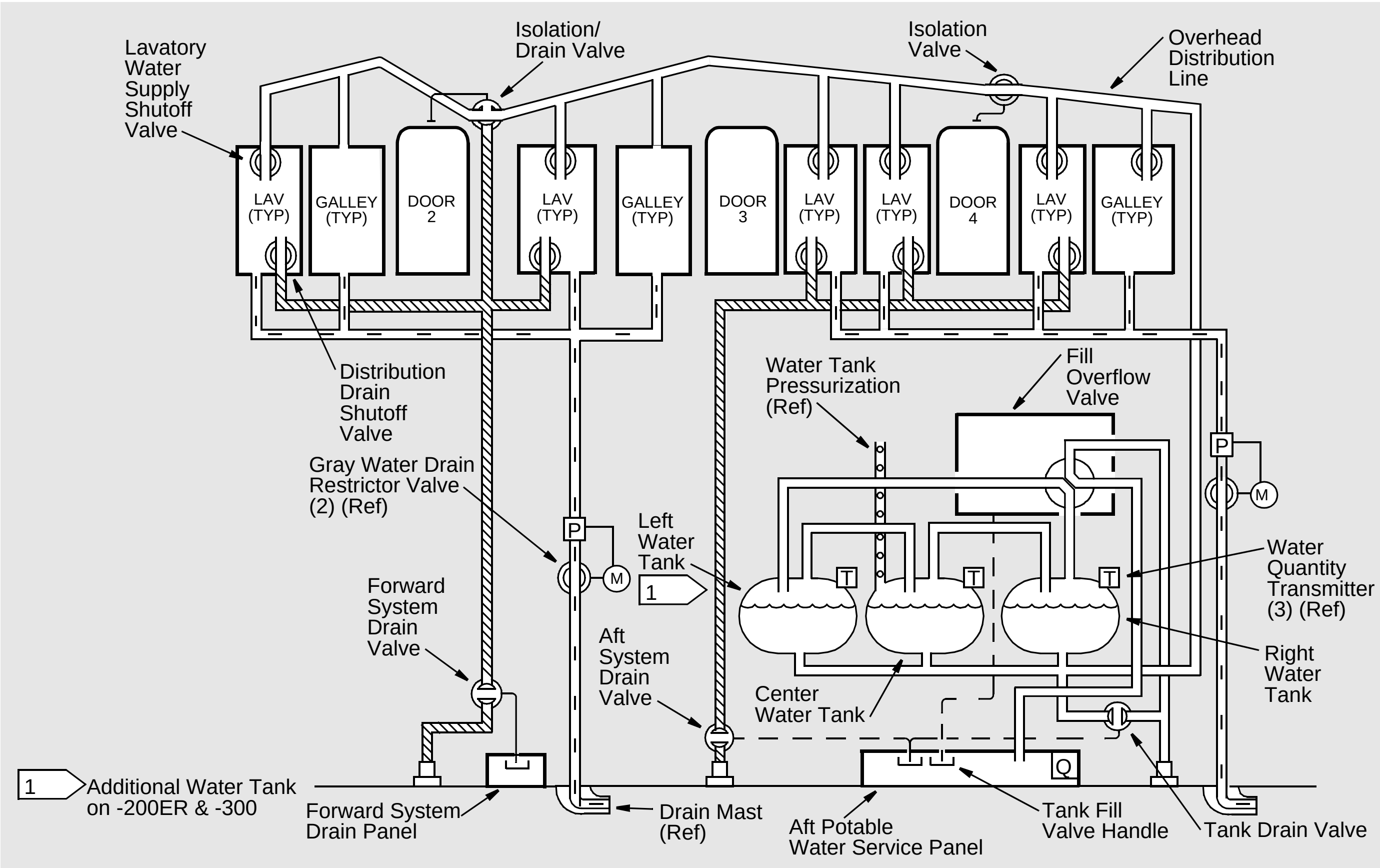
- Starts flow through both flow control units to the PSUs
- Releases the masks from the PSU.

Each mask has a shutoff valve (not shown) in the PSU. When a passenger or attendant pulls on a mask, it opens the valve for that mask.

There is an option for therapeutic oxygen mask fittings on the outboard PSUs. The therapeutic oxygen switch on the P5 starts flow through one flow control unit to the PSUs but does not cause the masks to drop. An attendant connects a mask to the fitting for a passengers use.

INDICATIONS

A light on the switch and on an EICAS message show when the masks are released.



Potable and Gray Water Systems

Potable Water System

There are two potable water tanks aft of the bulk cargo compartment. The usable quantity of each tank is 109 gallons (413 liters).

There is an additional water tank aft of the bulk cargo compartment. It can also contain 109 gallons (-200ER and -300).

Air pressure inside the tanks pushes the potable water through the distribution system to the lavatories and galleys. The pressure comes from the pneumatic system or a compressor. A pressure switch on the tank starts the compressor when tank pressure is low. The compressor does not operate when you open the fill overflow valve.

The tank quantity sensors and transmitters give information to:

- The cabin services system
- Service panel gages
- Optional quantity preselect systems (not shown).

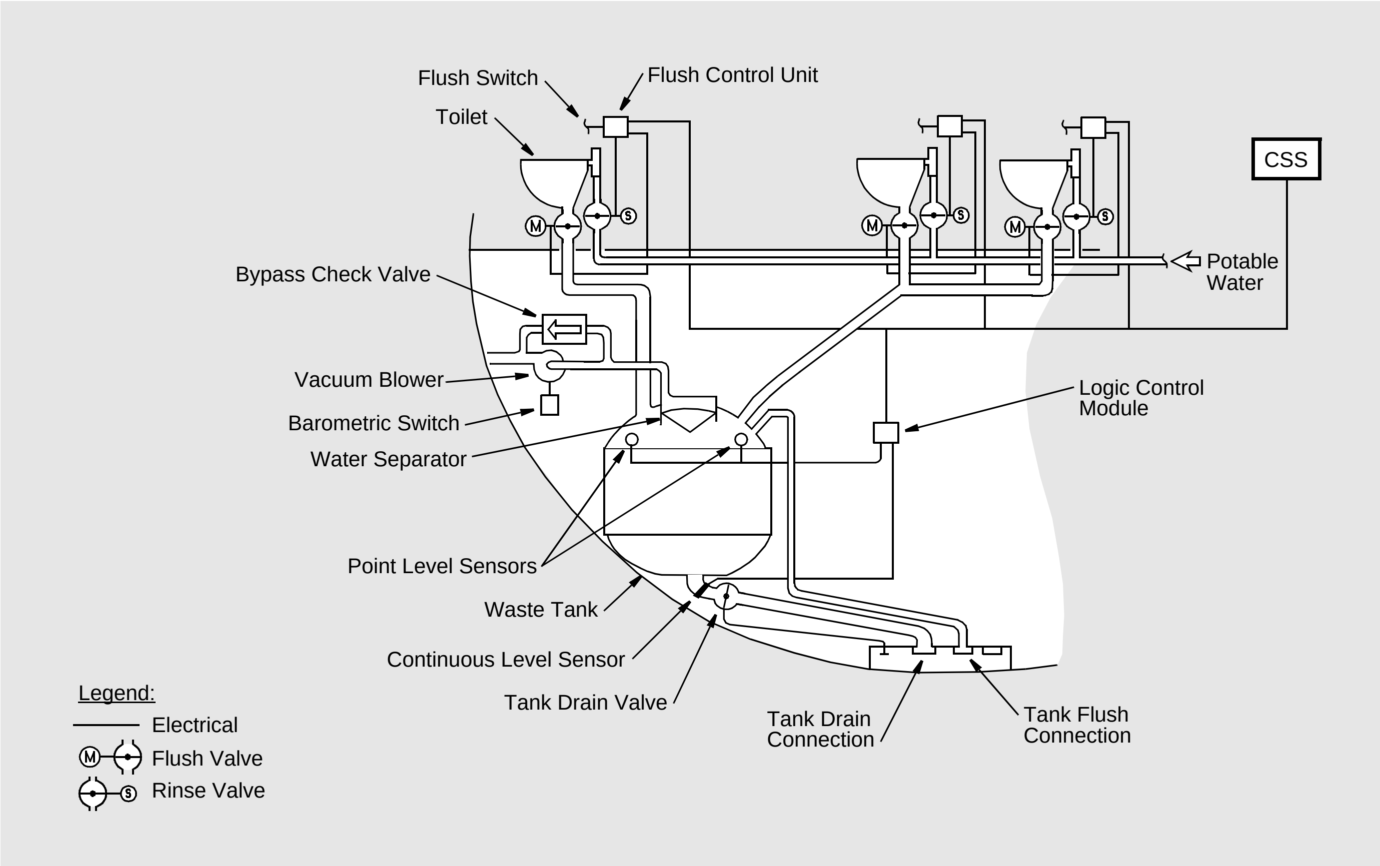
The standard system configuration has an aft potable water service panel and a forward potable water system drain panel. The aft service panel is below the aft end of the aft cargo compartment. The drain panel is forward of and below the right wing.

You use the aft panel to fill. You can use the gage to monitor the quantity, or fill the tanks until water comes out of the tank overflow and drain.You use both the forward and aft panels to drain the system.

There is a quantity preselect option (not shown). The controls and fill connections can be on a dedicated forward potable water service panel below the number one left passenger door, or on the aft potable water service panel. You use a switch to select the quantity. The fill valves open. They close when the selected quantity is in the tanks.

Gray Water System

The gray water system drains water from the galley and lavatory sinks through two drain masts on the bottom of the fuselage. There are restrictor valves in the system to reduce air noise. Water pressure in the lines opens the valves. They are fail safe to the open position and are open on the ground.



Lavatory Waste System

Lavatory Waste System

Each lavatory has a vacuum toilet. Three waste tanks outboard of the left wall of the bulk cargo compartment hold the waste. The total waste capacity is 189 gallons for the 777-200 and -200ER. The total waste capacity is 229 gallons for the 777-300. The waste tank service panel is on the bottom aft fuselage.

Waste lines connect the lavatories to the waste tanks. Each tank gets waste from a specified group of lavatories.

A vacuum in the tank pulls the waste from the toilet into the tank. Below 16,000 feet, a vacuum blower causes the vacuum. Above 16,000 feet, the ambient atmosphere causes the vacuum.

There are two vacuum blowers. One is for the forward tank, and the other is for the mid and aft tanks.

Each toilet has a flush switch that connects to a flush control unit (FCU). When a person pushes the flush switch, the FCU starts the flush cycle. During the flush cycle:

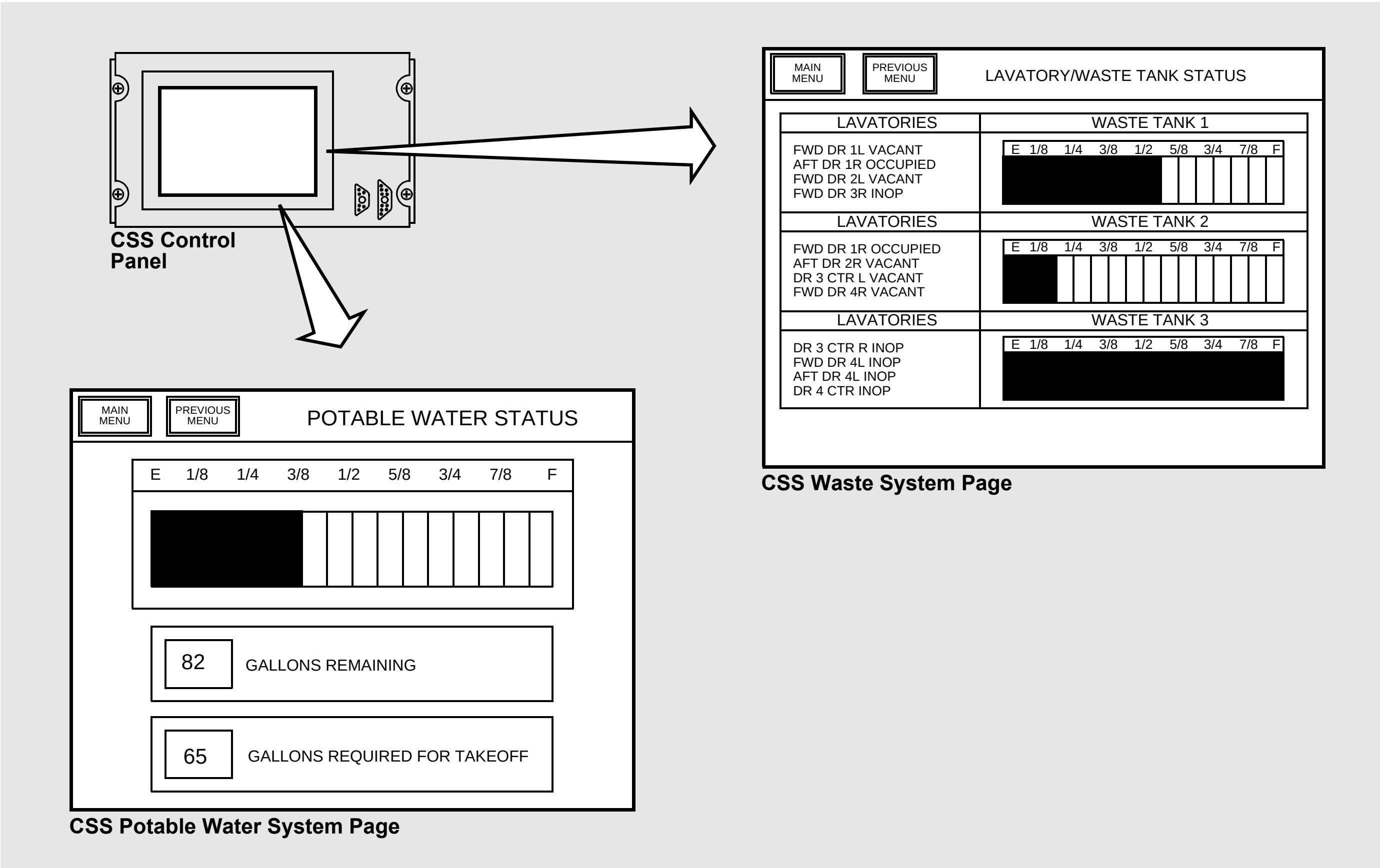
- The waste moves from the toilet into the waste tank
- Potable water flushes the toilet.

There are two tank full sensors and a logic control module (LCM) for each tank. If a tank is full, the LCM:

- Prevents operation of the lavatories that connect to that tank
- Shows a tank full message on the CSS.

There is a continuous level sensor and two point level sensors on each tank. Sensor information goes to an LCM on each tank. Continuous level sensor information shows on the CSS. The point level sensor information is used to stop toilet operation when a tank is full.

The waste tank service panel has one drain connection. It has a drain handle and a rinse connection for each of the three tanks. This lets the ground crew do servicing of each tank independently from the other tanks.



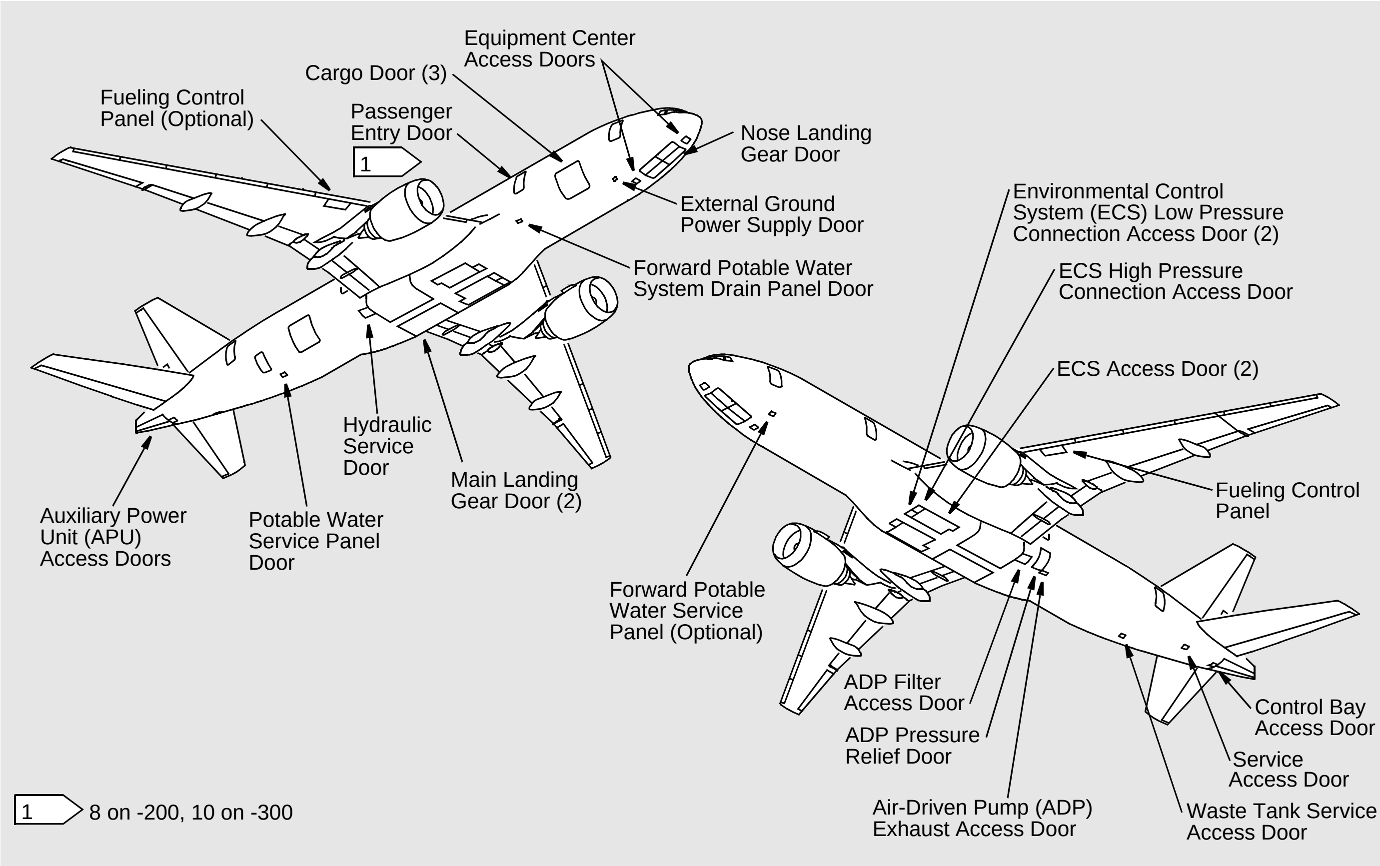
Water and Waste Systems Display

Water and Waste Systems Displays

The potable water system and the lavatory waste system each have a CSS page. The potable water system page shows the quantity of potable water in both tanks.

The lavatory waste system page shows the waste level in each waste tank. It also shows which lavatories:

- Are in use
- Are not in use
- Have been locked by an attendant because they are inoperative.

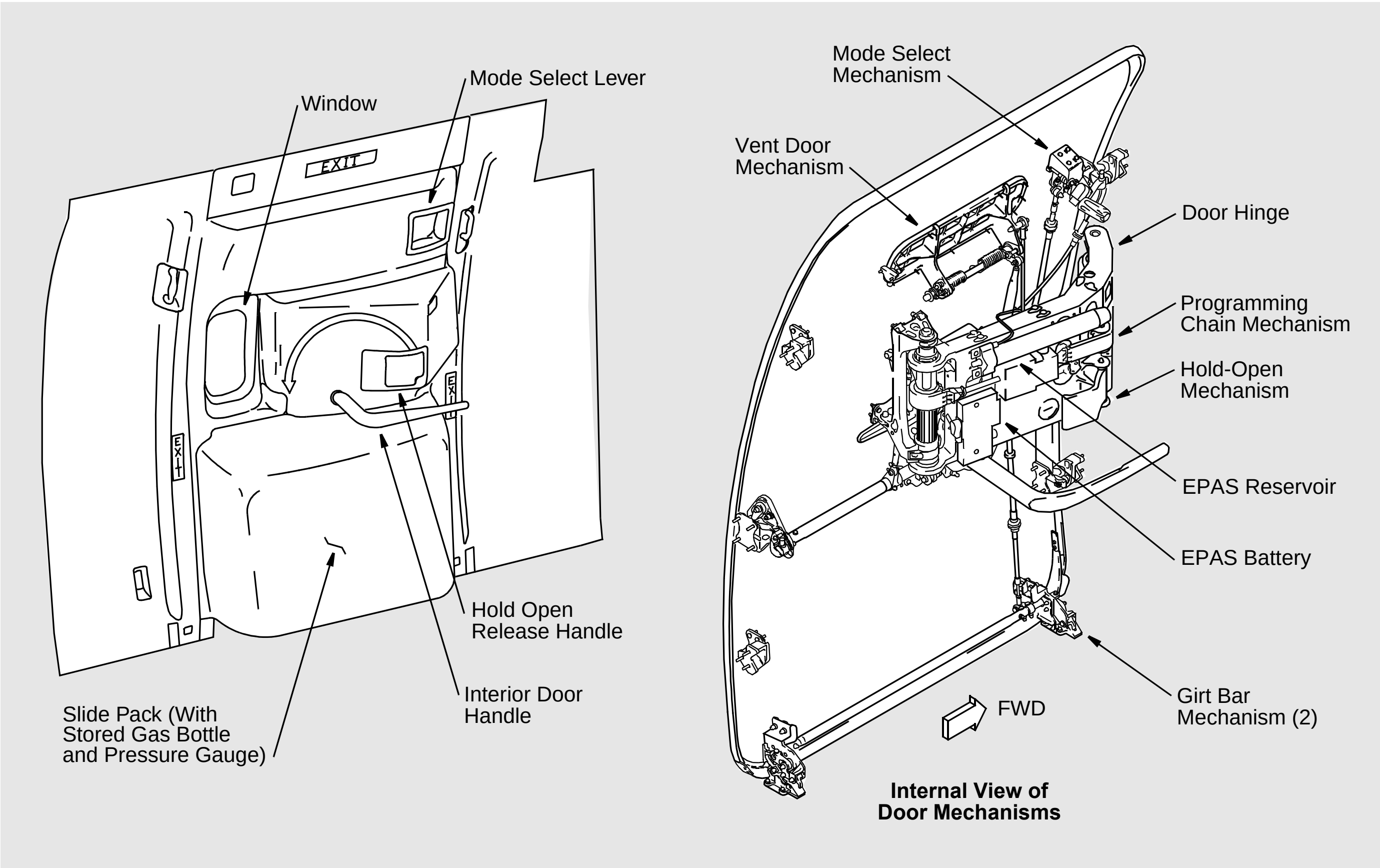


Doors

Doors

Doors give access to these areas:

- Passenger and flight compartments
- Cargo compartments
- Equipment centers
- Service areas.



Passenger and Service Entry Doors

Entry Doors

There are four passenger entry doors on each side of the airplane (-200).

There are five passenger entry doors on each side of the airplane (-300). The overwing doors are for emergency use only.

The door openings have sufficient width to let two people go through the door at the same time.

The doors are plug type that open outward. There are stops on the door and on the door frame. The door stops put the pressurization load on the frame stops.

All of the doors operate manually from inside and outside of the airplane. A single hinge arm attaches the middle of the door to the door frame. The mechanism that connects the door to the hinge permits this door movement:

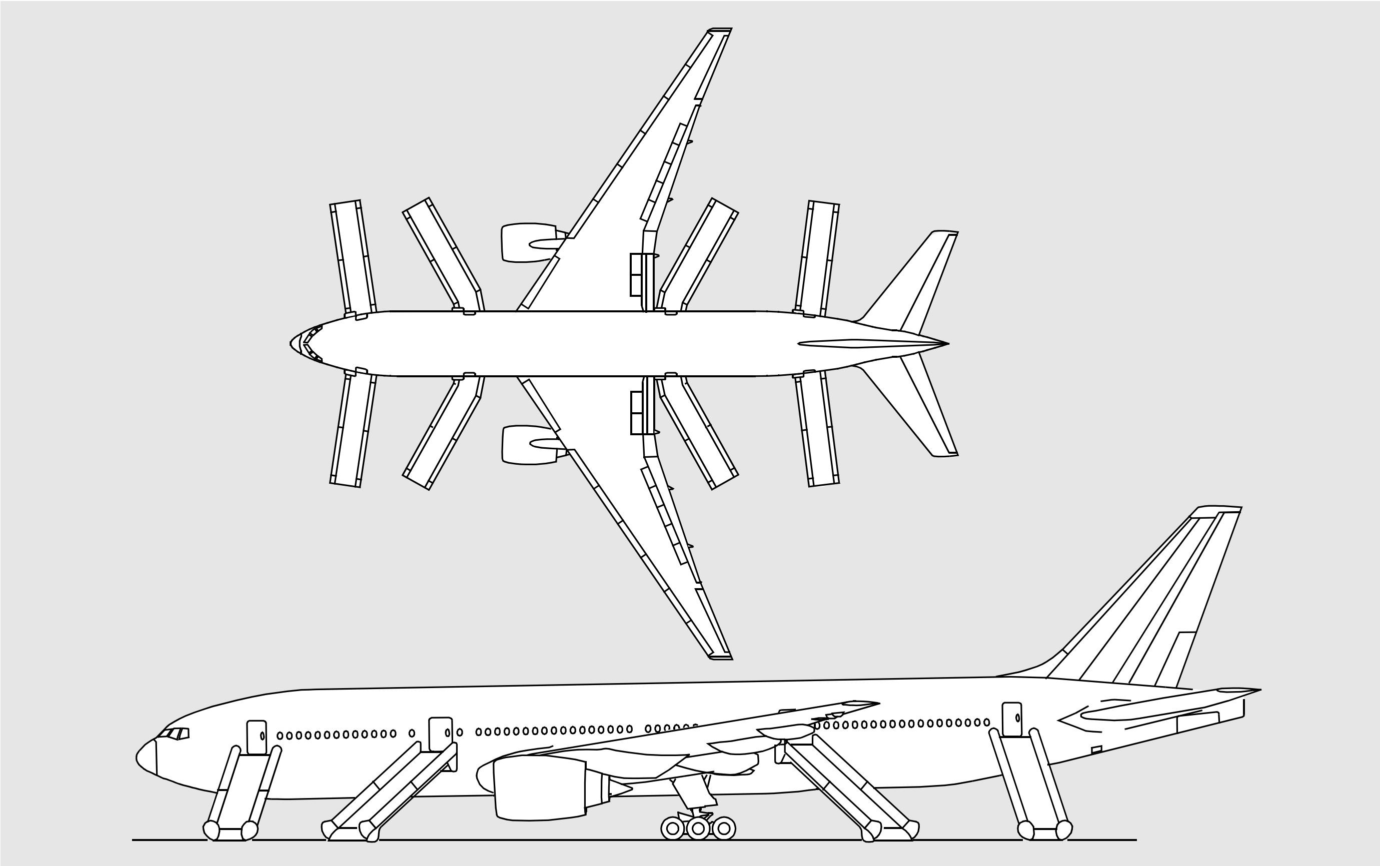
- Move up and down
- Turn in relation to the hinge arm.

As the door opens, it first moves up so the door stops can move over the frame stops. The door then moves outward and forward. The programming mechanism chain keeps the inboard side of the door toward the airplane. The door does not turn in relation to the airplane. The inboard side of the door always faces inboard.

A hold-open mechanism holds the door in the open position.

The mode select lever lets the cabin attendants arm the emergency power assist system (EPAS) and the escape slides. The EPAS uses compressed gas from a reservoir to help open the doors in an emergency. The gas goes from the reservoir to an actuator (not shown). The actuator connects to the programming chain. It uses the chain to open the door.

Each door has a flight lock assembly that locks the door when airspeed is more than 80 knots.



Emergency Escape System (-200)

Emergency Escape System

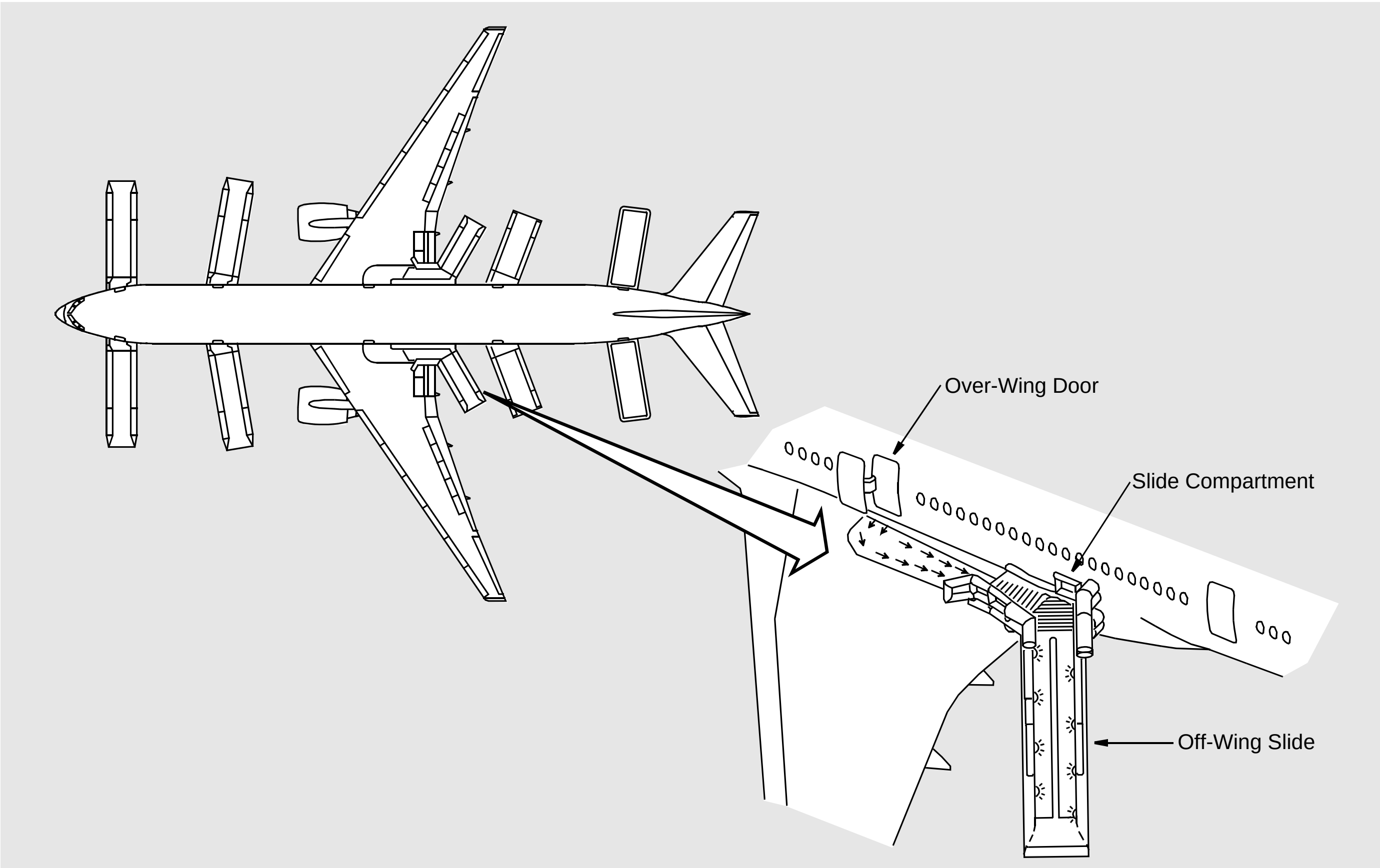
There is an escape slide/raft at each passenger entry door. A bustle covers each slide/raft.

Each slide/raft has two passenger lanes. Lights on the end of the slides come on when the slides are inflated. They are safe for use in winds up to 25 knots, and with the collapse of one or more of the landing gear.

The mode select lever on the door lets the cabin attendants arm the emergency power assist system (EPAS) and the escape slides. The EPAS opens the door when it is armed and you move the interior door handle to the open position.

As the door opens, the slide/raft releases from the door. This starts the slide/raft inflation sequence.

When you use the external door handle, the EPAS and escape slide automatically disarm.



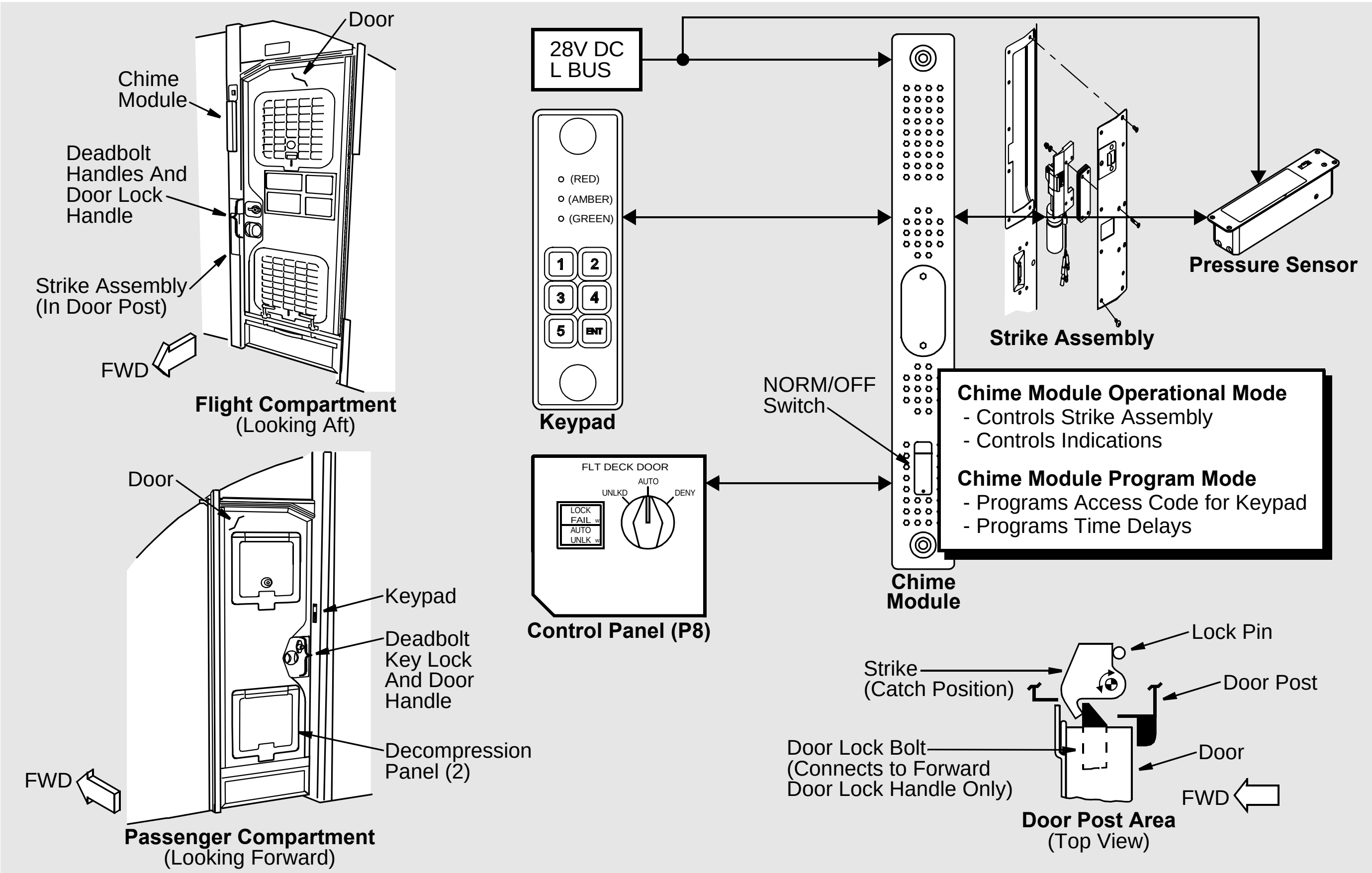
Off-Wing Escape System (777-300)

Off-Wing Escape System

The off-wing escape system lets passengers and crew get off the wing after they go out of the airplane through the number three passenger entry (over-wing) door.

There is an off-wing slide for each wing. The slide is stowed in a compartment aft of the wing in the wing-to-body fairing. The inflation bottle is in a compartment in the wing-to-body fairing below the wing.

Operation of the over-wing door is the same as the other passenger entry doors. The off-wing slide inflates when you open the door in the armed mode.



Flight Compartment Door

Flight Compartment Door

The flight compartment door divides the flight compartment from the passenger cabin. The door and the structure around the door gives ballistic and intruder protection to the flight compartment. The door opens forward into the flight compartment.

The mechanical part of the door has these main components:

- Decompression panel (2)
- Door lock assembly
- Deadbolt assembly.

The decompression panels open aft if the passenger cabin has a loss of pressurization.

The door lock assembly has one handle on the flight compartment side of the door that operates the door lock bolt. The handle on the passenger side of the door lets you move the door but does not connect to the door lock bolt.

The deadbolt assembly has handles on the forward side of the door and a key lock on the aft side of the door. The handles let you extend or retract a deadbolt and let you enable or disable key operation.

The electrical part of the flight compartment door is the flight deck access system (FDAS). This system has these components:

- Chime module
- Door strike assembly
- Pressure sensor
- Control panel
- Keypad.

The chime module is a computer that controls the system. It controls the strike assembly and system indications. It also lets you set the access code and system time delays.

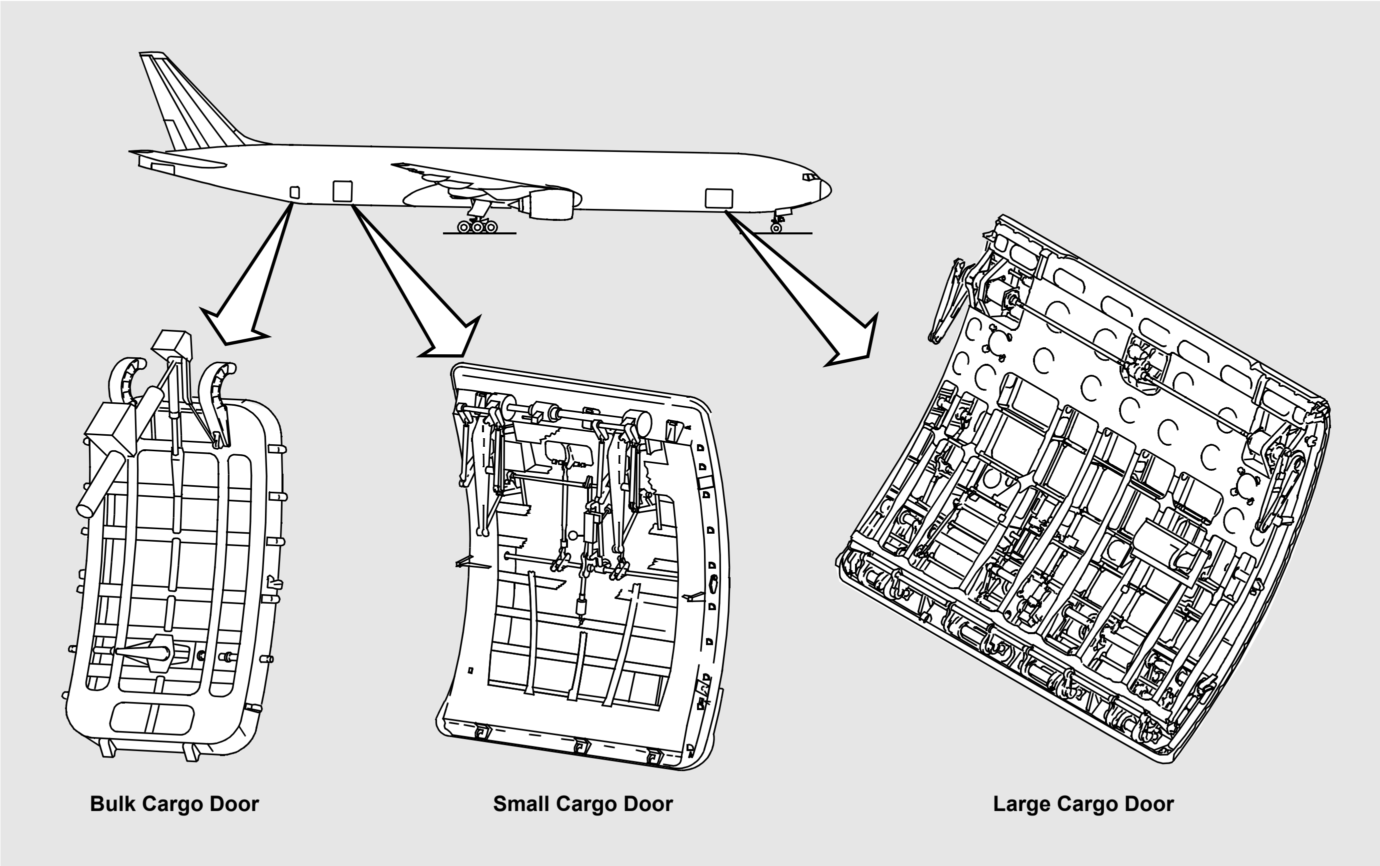
The strike assembly has a solenoid that extends or retracts a pin to lock or release the strike.

The pressure sensor finds a loss of pressurization in the flight compartment. If there is a loss of pressurization, the sensor opens the circuit to the solenoid in the strike assembly. This releases the strike and lets the door open to make the pressure equal.

The pilots can control the strike assembly with a switch on the control panel. Lights on the control panel show system status.

A keypad lets authorized people go into the flight compartment after they put in the correct access code.

Power to lock the strike comes from 28v dc left bus. If power is lost, the door strike releases. This safety feature releases the door strike in an emergency.



Cargo Doors

Cargo Doors

BULK CARGO DOOR

The bulk cargo door opening lets you load items that are not in containers or on pallets.

The door is a plug type that opens inward and upward. Two hinge arms attach the top of the door to the airplane. There are exterior and interior handles. The door operates manually. A counterbalance helps you open the door.

SMALL CARGO DOOR

The small cargo door is standard on the aft cargo compartment. The door opening lets you load cargo in containers and one-half size pallets.

The door opens outward. Two hinge arms attach the top of the door to the airplane. Electric actuators open and close the door.

The door is a plug type. There are stops on the door and door frame. As the door closes, it lowers to a position where the door stops are inboard of the frame stops. When the airplane is pressurized, the door stops put the pressurization load on the frame stops. This holds the door closed.

There are control panels inside and outside of the compartment.

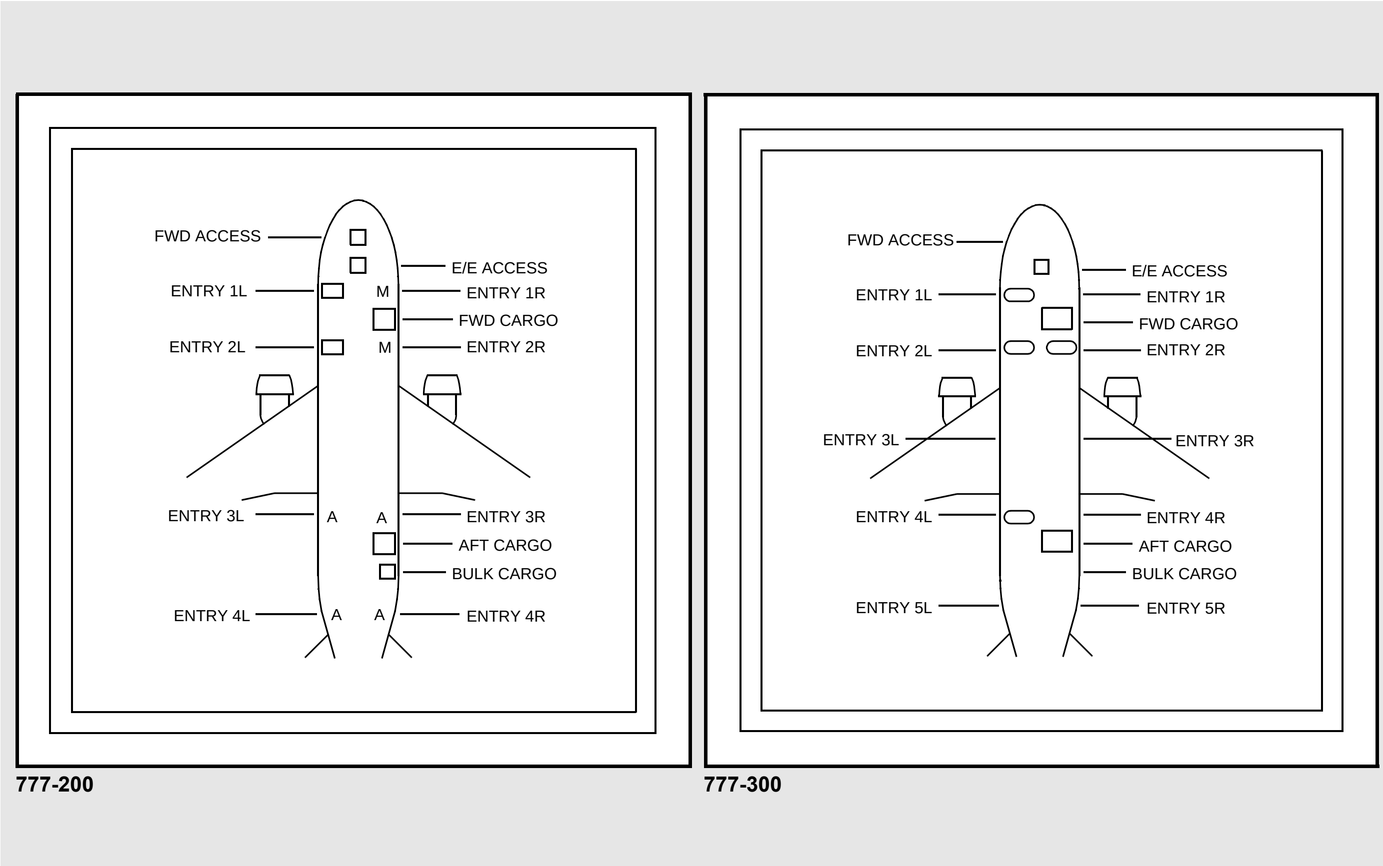
LARGE CARGO DOOR

The large cargo door is standard on the forward cargo compartment, and optional on the aft. The size of the door opening is sufficient for cargo on pallets.

A continuous hinge along the top of the door attaches it to the airplane. The door opens outward.

The door is not a plug type door. Latches and locks hold the door closed. Electric actuators lock and unlock, and open and close the door.

There are control panels inside and outside of the compartment.

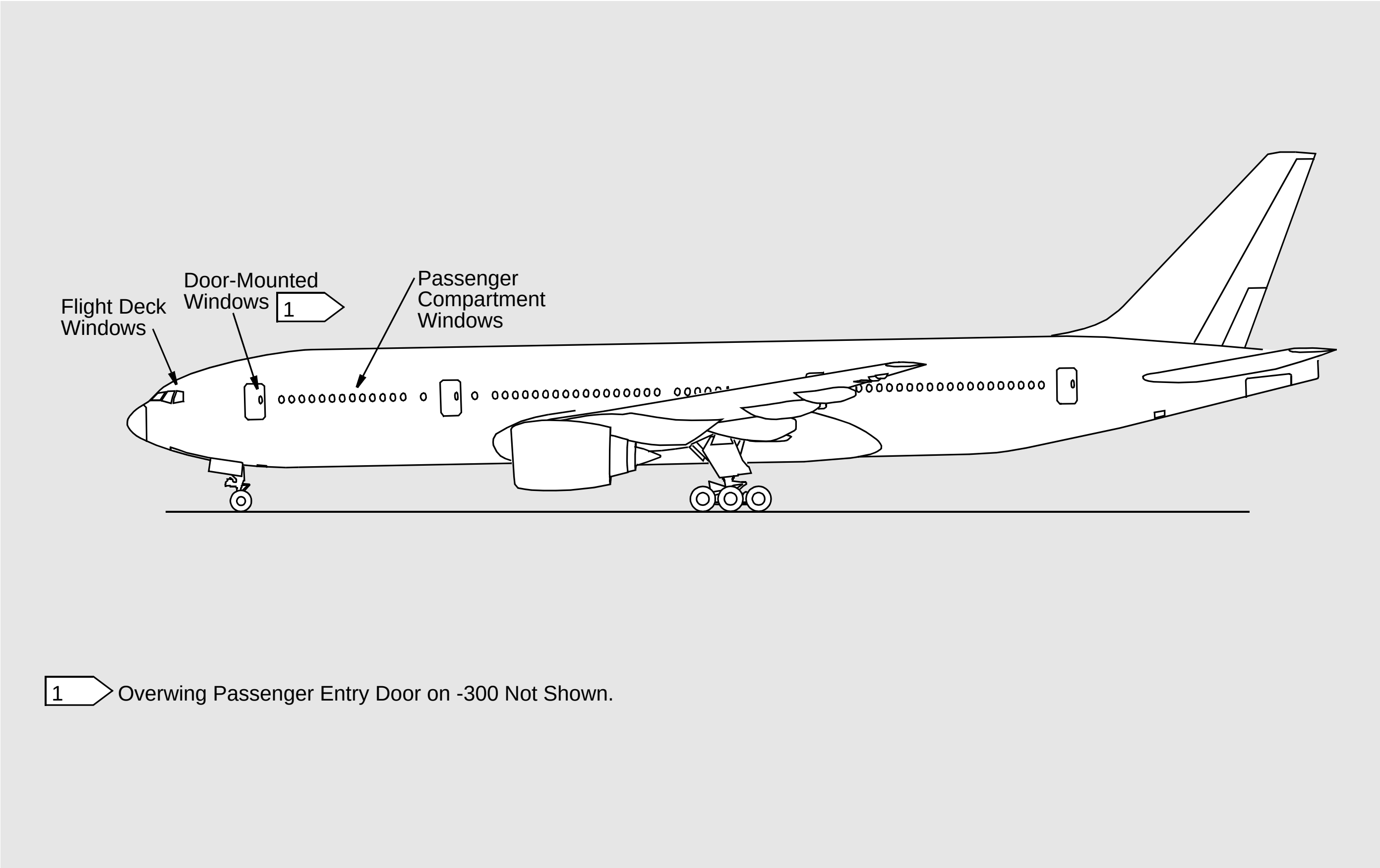


Door Synoptic Display

Door Synoptic Display

The door synoptic display shows the doors. An amber box shows an open door. The box goes away when the door is closed.

There is an option to show if a door is in the manual (disarmed) or automatic (armed) mode. The symbol M identifies a door in the manual mode. The symbol A identifies a door in the automatic mode.



Windows

Windows

The flight deck has three windows on each side. Number one window is in the front. Number three window is in the back. The number two window opens from inside the flight deck.

There is a window in each passenger entry door.

Passenger compartment windows are along both sides of the passenger compartment.

Lights

Features

FLIGHT DECK LIGHTING

Panel lights give light to the instruments for the flight crew. Each flight crew position has a map light, chart light, and a work table light. Dome lights are in the ceiling of the flight deck.

EXTERIOR LIGHTS

Landing lights on the wings and nose landing gear show the runway to the flight crew. Anti-collision lights and position lights show the airplane to the flight crews in other airplanes. Logo lights on the horizontal stabilizers give light to the airline logo on the vertical stabilizer.

CABIN LIGHTING

The cabin services system (CSS) controls the passenger cabin lighting.

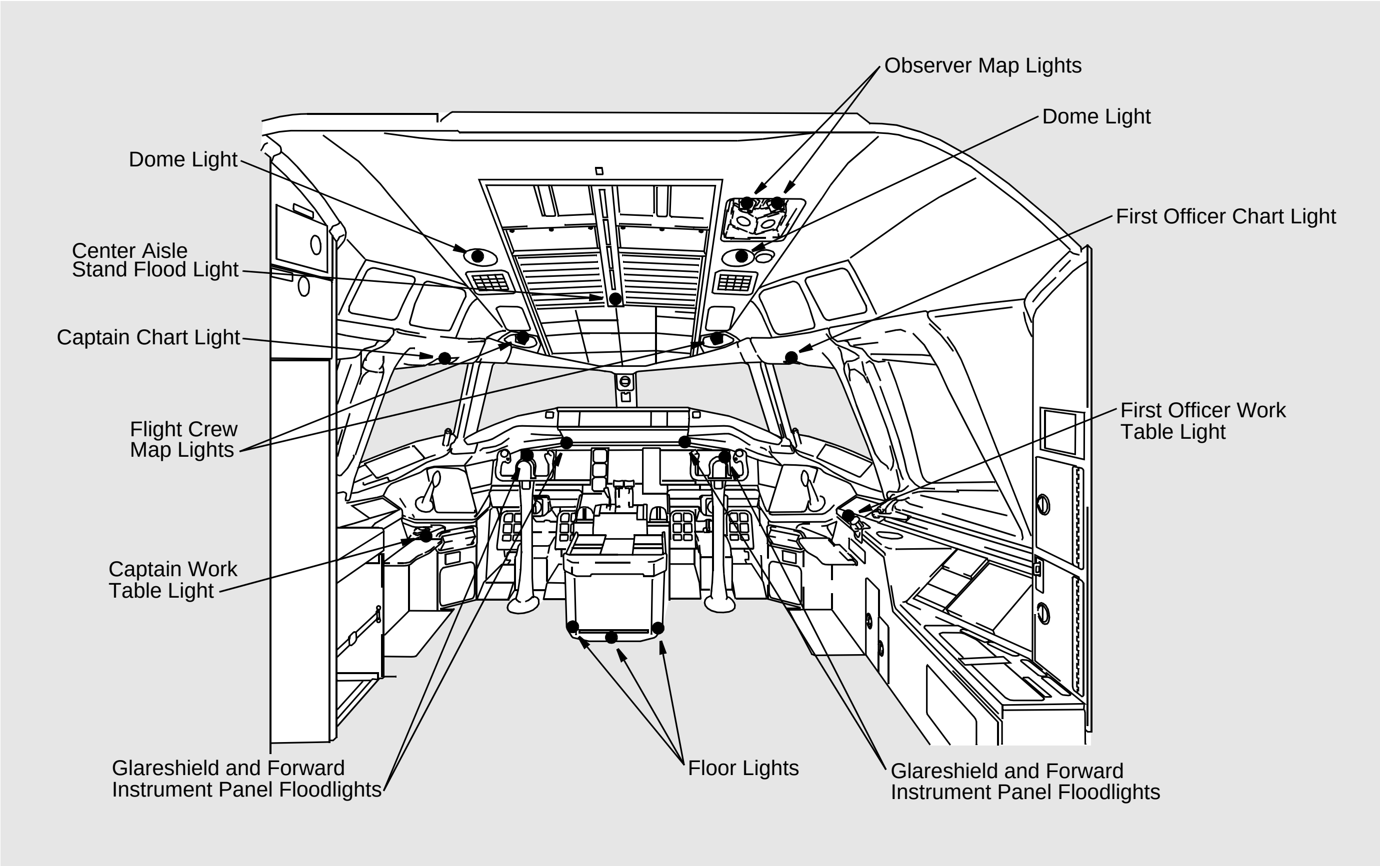
SERVICE AND CARGO LIGHTS

There are lights in all of the service and cargo compartments for the ground crew. Cargo loading lights give light during cargo loading.The cargo loading lights are on the outside of the fuselage and on the inside of the forward, aft, and bulk cargo doors.

EMERGENCY LIGHTS

Emergency lights show the emergency escape routing to the passengers and crew.

- **Flight Deck Lights**
- **Flight Deck Light Controls**
- **Exterior Lights**
- **Exterior Light Controls**
- **Lighting Control Displays**
- **Service and Cargo Lights**
- **Emergency Lights**

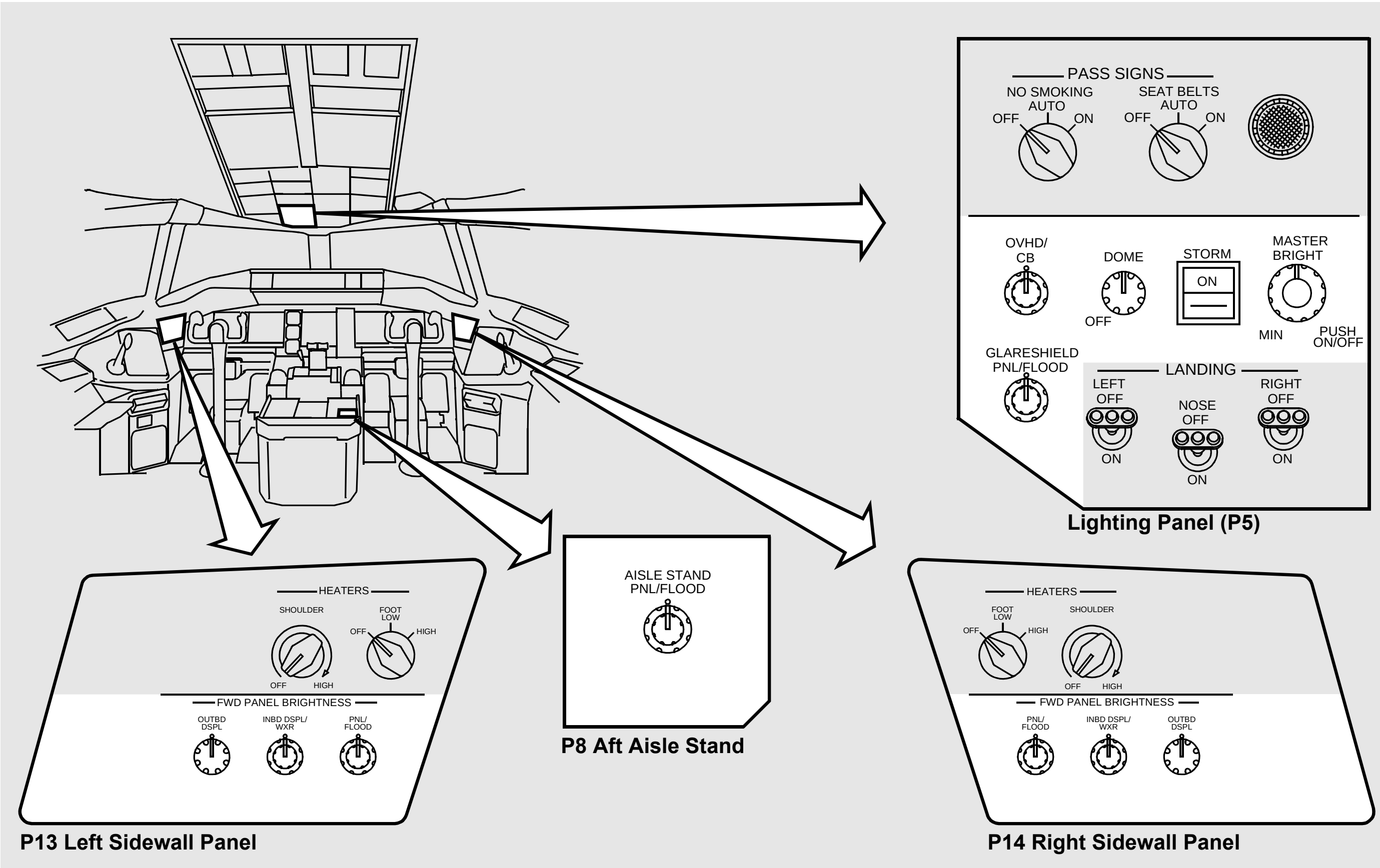


Flight Deck Lights

Flight Deck Lights

The flight deck has these lights:

- Integral panel lights for all of the instrument and circuit breaker panels
- Flood lights for all of the panels except the overhead panel
- Dome lights
- Map lights for the flight crew and observers
- Chart lights for the captain and first officer
- Work table lights for the captain and first officer
- Floor lights
- Utility lights for the observers.



Flight Deck Light Controls

Flight Deck Light Controls

The P5 overhead panel has controls for these lights:

- Panel and flood lights for the glareshield instrument panel
- Panel lights for the overhead circuit breaker panel
- Dome lights
- Storm lighting
- Master brightness control.

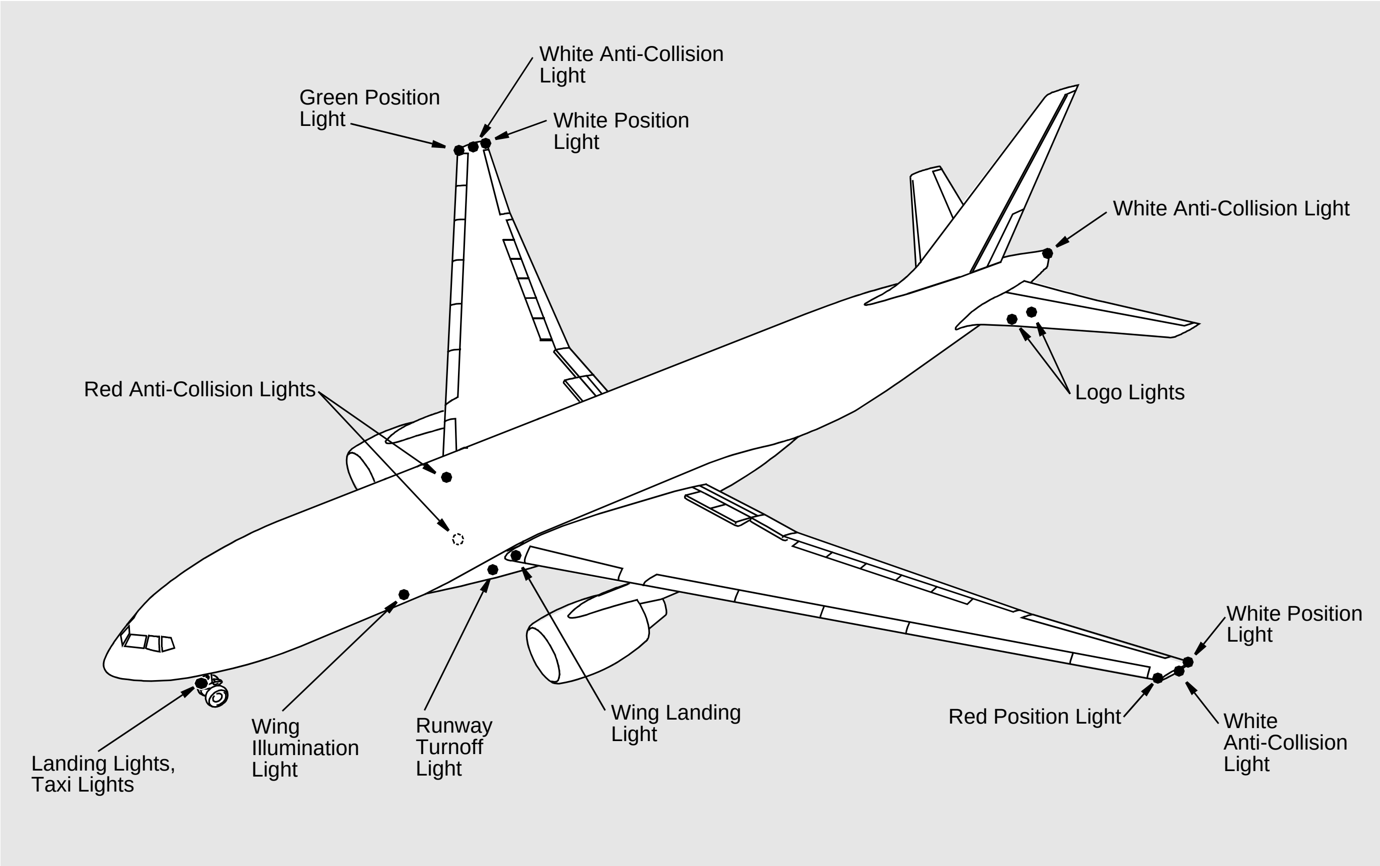
The storm lighting control lets you turn on these lights to the full bright level:

- Dome
- Flood
- Lighted switches
- System annunciator lights that are on.

A master bright control on the P5 overhead panel lets you control all of the panel and instrument lights together. You can also use individual controls for the panel lights.

The individual panel and flood light controls for the forward instrument panels are on the left and right sidewall panels.

The individual panel and flood light control for the aisle stand instrument panel is on the aft end of the aisle stand.



Exterior Lights

Exterior Lights

The wings have these lights:

- One white anti-collision light on each wing tip
- One red and one white position light on the left wing tip
- One green and one white position light on the right wing tip
- One main landing gear (MLG) ground maneuver camera light on the outboard flap outboard support fairing on each wing (777-300).

The fuselage has these lights:

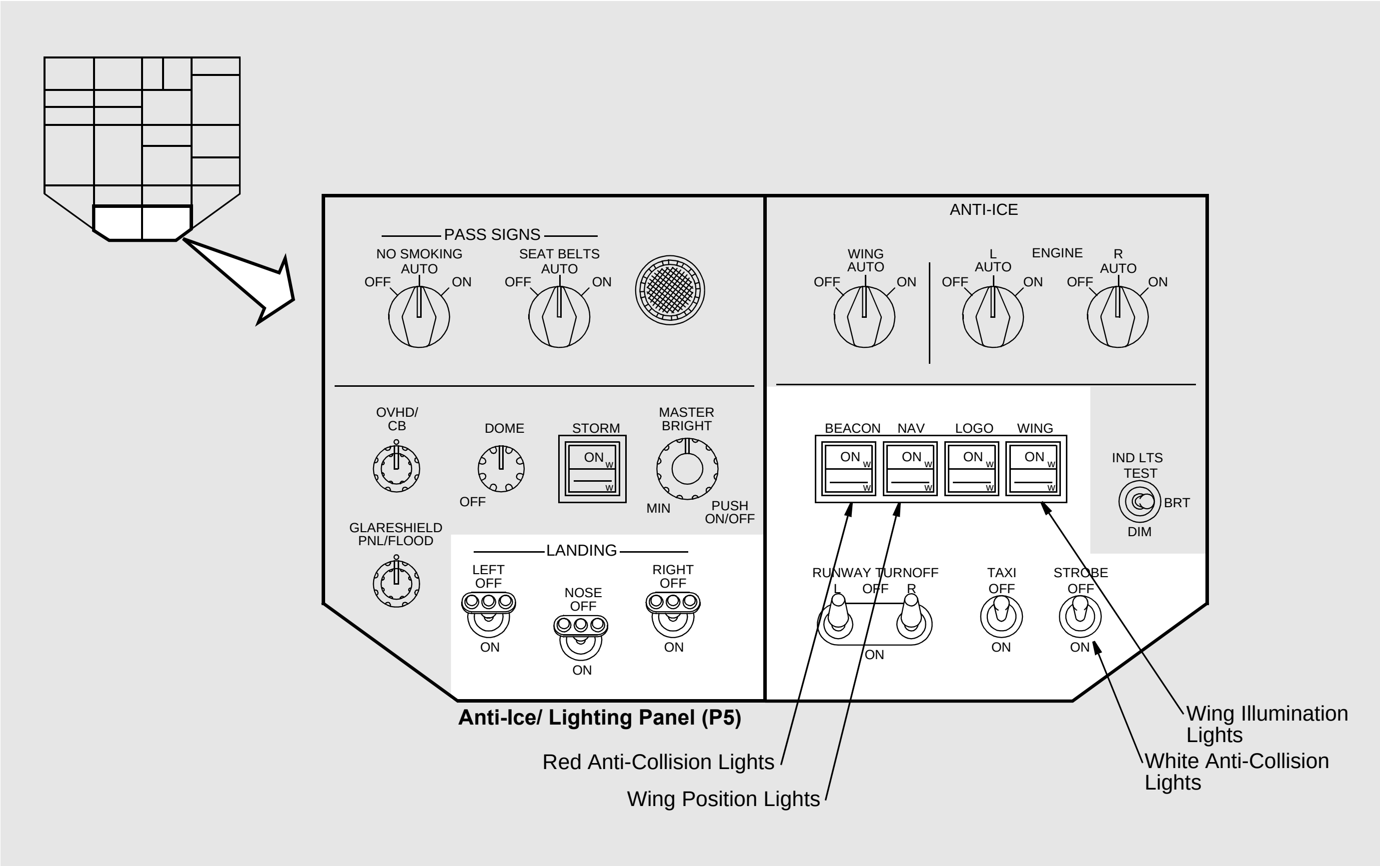
- One red anti-collision light on the top and one on the bottom
- One landing light at the inboard forward edge of each wing
- One runway turnoff light located with the landing light
- One wing illumination light on each side, forward of the wing.

The empennage has these lights:

- One white anti-collision light on the aft end
- Two logo lights on the top of each horizontal stabilizer.

The nose gear strut has these lights:

- Two landing lights
- Two taxi lights
- One nose landing gear (NLG) ground maneuver camera light (777-300).

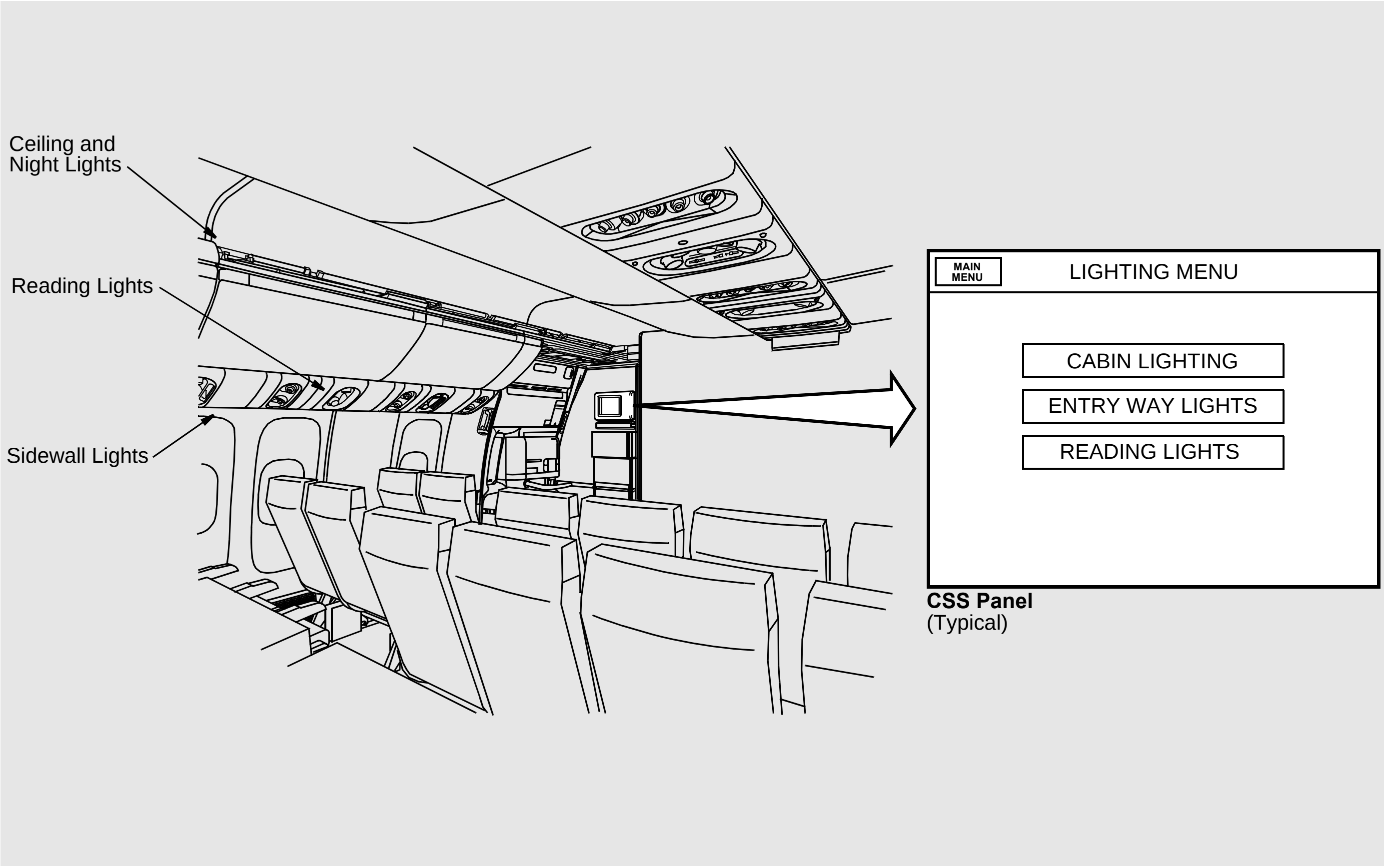


Exterior Light Controls

Exterior Light Controls

The P5 overhead panel has controls for these exterior lights:

- Landing lights
- Red anti-collision lights (beacon)
- Wing position lights (nav)
- Logo lights
- Wing illumination lights
- White anti-collision lights (strobe)
- Taxi lights
- Runway turnoff lights.



Passenger Cabin Lights

Passenger Cabin Lights

Ceiling lights are fluorescent tubes above the outboard stowage bins. The light reflects off of the ceiling panels to light the passenger compartment.

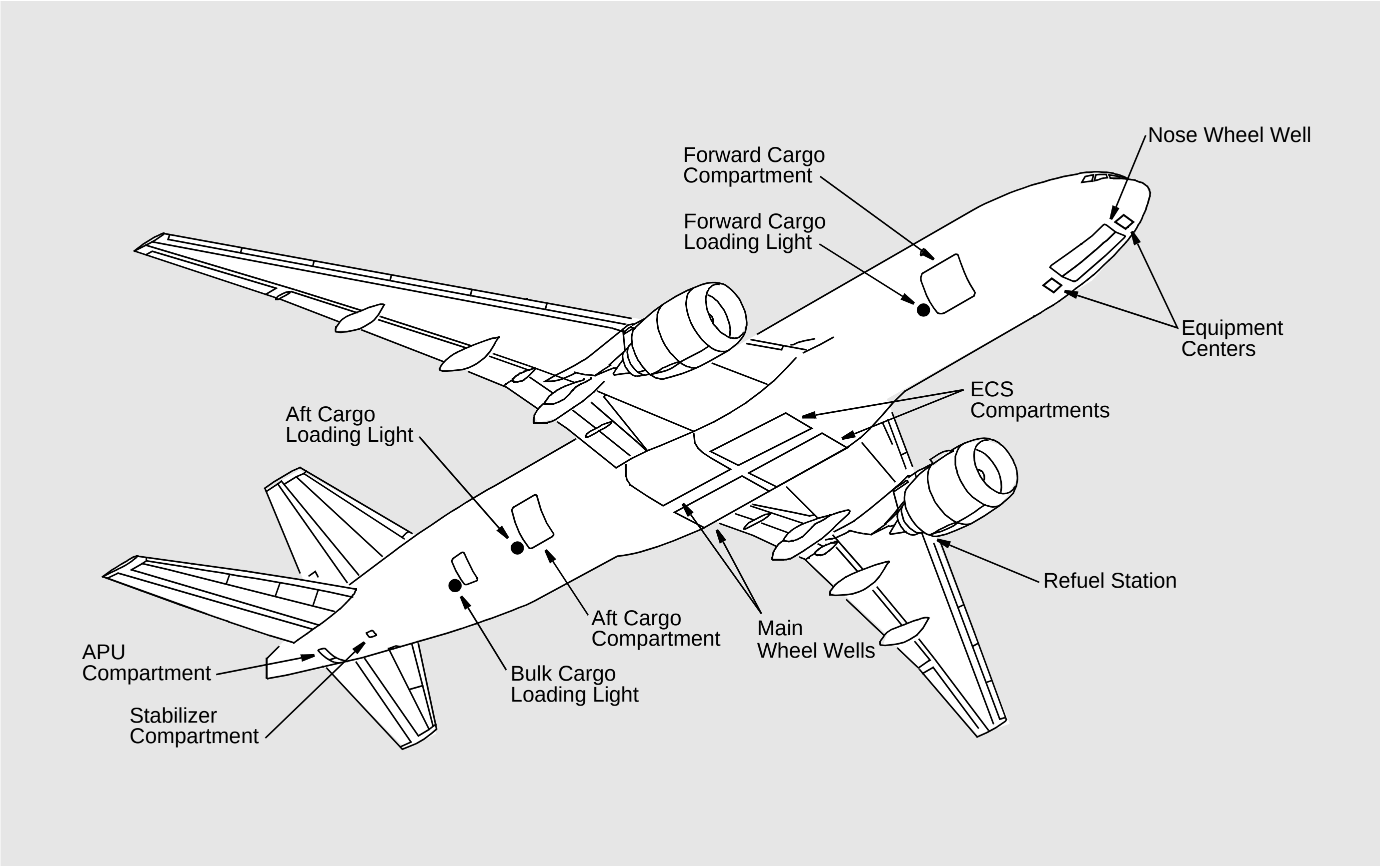
Night lights are incandescent bulbs that are with some ceiling lights in the cabin. They give a dim light when the ceiling lights are off.

Reading lights are incandescent bulbs in the passenger service units above the passenger seats. There is a light for each passenger.

The cabin attendants use the cabin services system (CSS) to control the lights. They select the:

- Cabin lighting screen to set the intensity of the ceiling lights or set the night lights on or off
- Entry lights screen to set the entry on or off
- Reading light screen to give control of the lights to the passengers, or to set the reading lights on or off.

When the passengers have control, they use individual controls at their seats to control the reading lights.



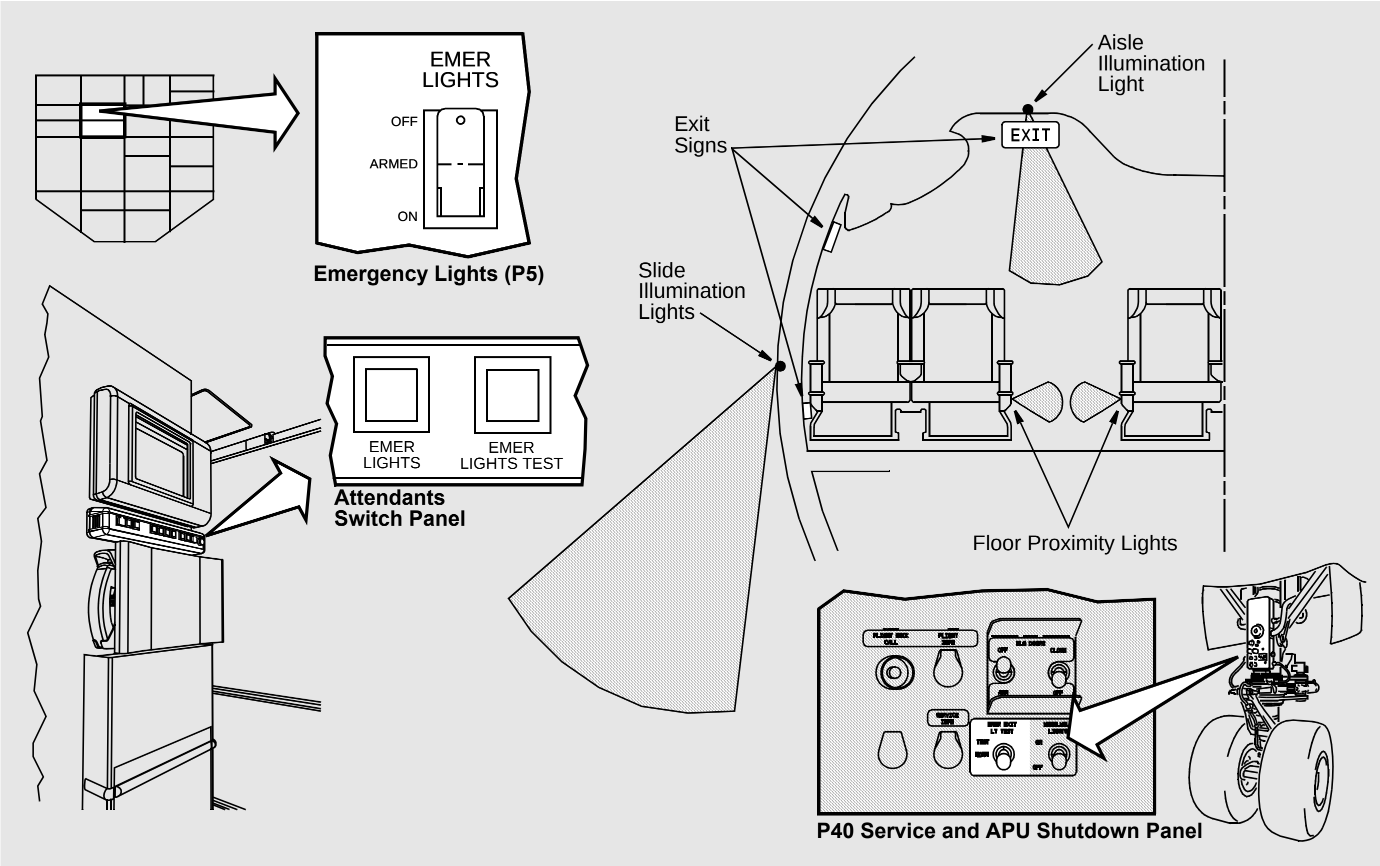
Service and Cargo Lights

Service and Cargo Lights

The ground crew uses lights in these locations:

- Nose and main gear wheel wells
- Equipment centers
- ECS compartments
- Refuel station
- Cargo compartments
- Stabilizer compartment
- APU compartment.

There are cargo loading lights on the fuselage aft of the cargo doors and on the inside of the door.



Emergency Lights

Emergency Lights

The passenger compartment has these emergency lights:

- Floor proximity lights on the sides of the aisle seats
- Aisle illumination lights in the ceiling with the air conditioning outlets
- Exit signs above and adjacent to the doors.

There are emergency escape slide lights on the outside of the fuselage, aft of the doors.

The emergency power supplies for the lights are above each door.

The emergency light switch for the flight crew is on the P5 overhead panel. There is one emergency light switch on the attendants panel. The panel can be at the left number one or two passenger door.

An EICAS advisory message shows when:

- The P5 emergency lights switch is not set to the armed position
- The attendant's emergency light switch is set to the on position.

These are the locations for the three emergency light test switches:

- P40 on the nose gear
- Attendants switch panel at the left number one or two passenger door
- Attendants switch panel at the left or right number four passenger door.

All of the emergency lights come on if one of the these occurs:

- The emergency lights switch on the P5 is set to armed and the electrical power fails
- The emergency lights switch on the P5 is set to on
- The emergency lights switch on the attendant's panel is set to on.

The emergency lights in the area near a passenger entry door will come on if the door is opened in the armed mode.

Cargo

Features

CARGO HANDLING

Forward and aft cargo compartments hold certified and uncertified containers. Bulk cargo compartment holds loose baggage. Forward and aft cargo handing systems let a single operator load or unload containers and pallets.

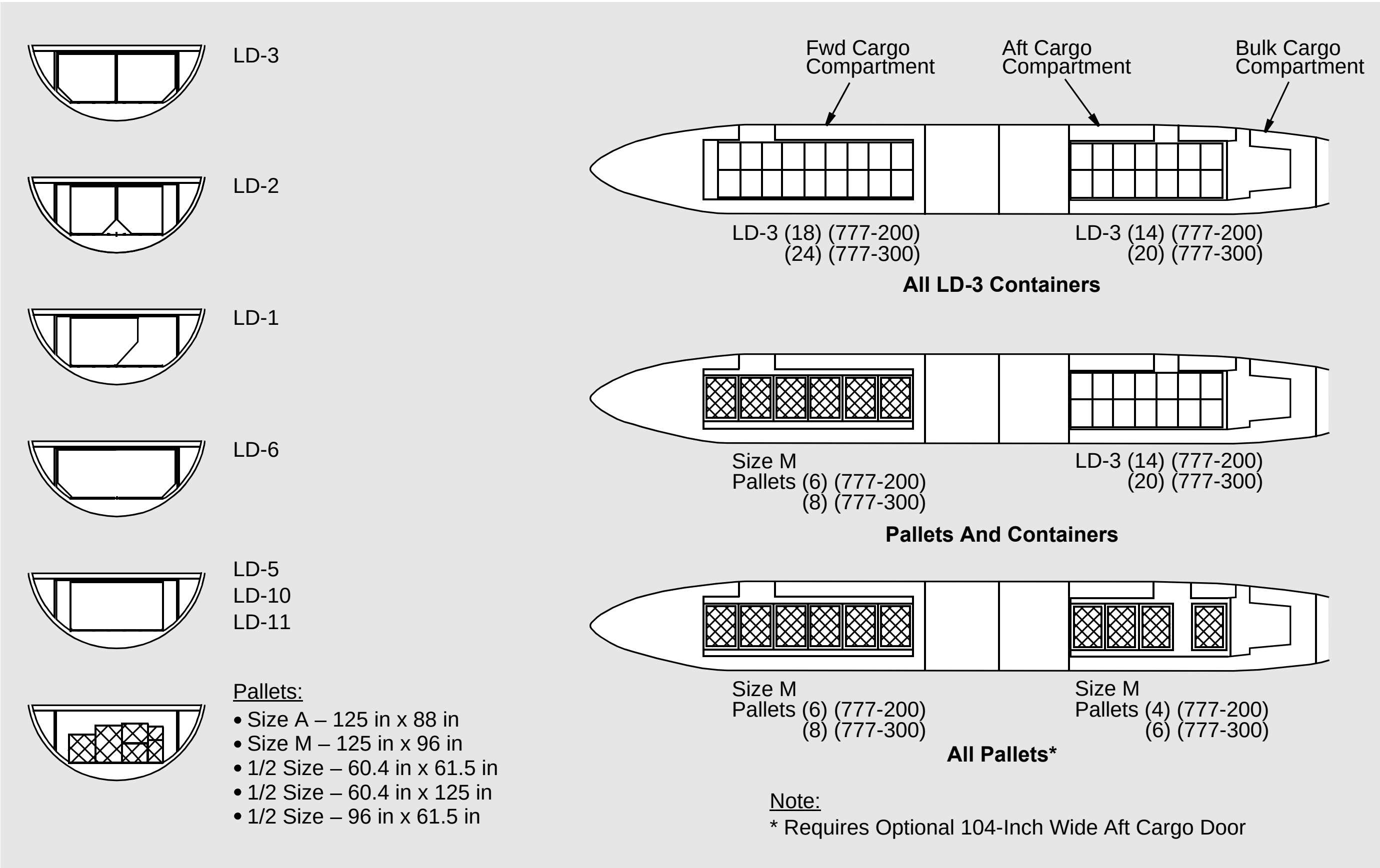
Two cargo handling system controllers control the operation of the cargo handling system components.

FIRE RESISTANCE

Compartment sidewalls, ceilings, and walkways are made of fire resistant materials.

The compartments meet these class-C requirements:

- Sidewalls and ceilings contain fire
- Smoke detection system gives warning to the flight compartment
- Fire extinguishing system lets the operator put fires out.



Compartment Features and Capacities

Cargo Compartments

These are the three cargo compartments in the lower deck:

- Forward cargo compartment
- Aft cargo compartment
- Bulk cargo compartment.

The forward and aft cargo compartments hold certified and non-certified unit load devices (ULD).

The forward cargo compartment holds these ULDs:

- LD-1
- LD-2
- LD-3
- LD-5
- LD-6
- LD-7
- LD-9
- LD-10
- LD-11
- Pallets (size A, M, and 1/2 size).

The aft cargo compartment holds these ULDs:

- LD-1
- LD-2
- LD-3
- LD-5
- LD-6
- LD-10
- LD-11
- 1/2 size pallets.

Optional equipment let both compartments hold these ULDs:

- LD-4
- LD-8.

The aft cargo compartment holds the larger ULDs if the airplane has the optional aft large cargo door.

The forward and aft cargo compartments have a cargo handling system.

A divider net separates the bulk cargo compartment from the aft cargo compartment.

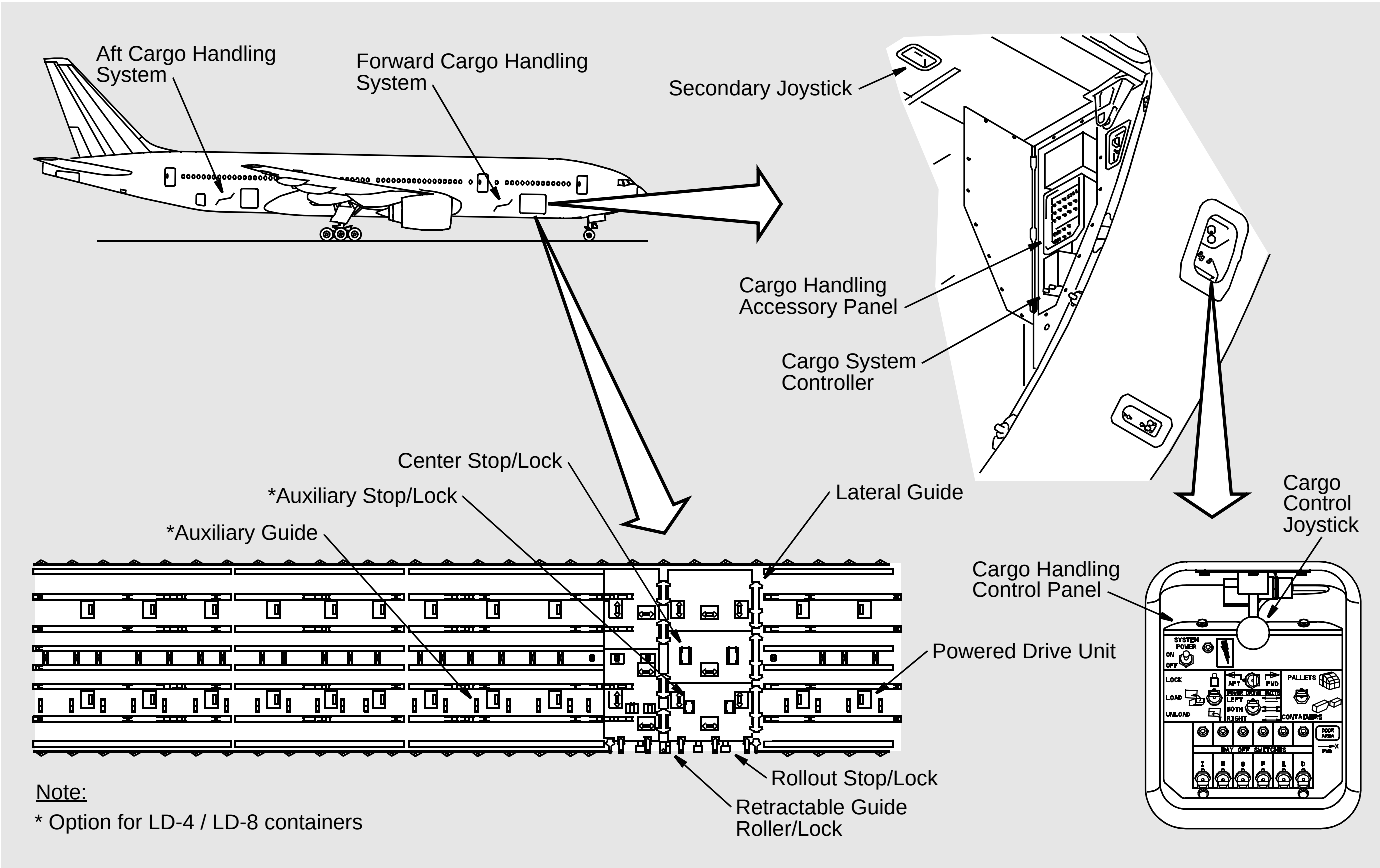
The cargo compartments have a lining of fire resistant material.

Cargo Capacities

The capacity of the forward cargo compartment of the 777-200 is 2,844 cubic feet (80.5 cubic meters). The capacity of the forward cargo compartment of the 777-300 is 3,792 cubic feet (107.4 cubic meters).

The capacity of the aft cargo compartment of the 777-200 is 2,212 cubic feet (62.6 cubic meters). The capacity of the aft cargo compartment of the 777-300 is 3,160 cubic feet (89.5 cubic meters).

The capacity of the bulk cargo compartment is 600 cubic feet (17 cubic meters).



Cargo Handling System

Cargo Handling System

A cargo handling system is in the forward and the aft cargo compartments. The operator uses an external joystick and control panel to set the configuration and operate the system. The operator may also use a secondary joystick in the ceiling of the compartment to operate the system.

The LD-4/LD-8 option adds these:

- Auxiliary Guides
- Auxiliary Lock/Stops.

Auxiliary guides and stop/locks give lateral and longitudinal restraint for LD-4/LD-8 containers.

Center lock/stops give separation and vertical restraint for LD-3 containers.

The lateral guides give these functions:

- Lateral guidance for container
- Longitudinal restraint for all ULDs
- Vertical restraint for pallets.

Powered drive units (PDUs) move the ULDs laterally and longitudinally.

Rollout stop/locks give lateral and vertical restraint.

The retractable guide roller/lock guides containers through the doorway and gives vertical restraint for pallets and containers.

There are switches on the cargo handling control panel and a switch near the cargo handling accessory panel. The switches let the operator set the configuration of the system for these functions:

- System power on/off
- Lock, load or unload
- Type of ULD
- PDU operation.

A joystick above the cargo handling control panel operates the PDUs for lateral and longitudinal movement of cargo.

The secondary joystick lets the operator move ULDs longitudinally from inside the cargo compartment.

The cargo handling system also has these components:

- Guides
- Rollers
- Stops/Locks
- Restraints.

The operator moves the ULDs manually if the PDUs do not operate.

Abbreviations and Acronyms

A

A/B	autobrake
ac	alternating current
ACAC	air cooled air cooler
ACARS	aircraft communications addressing and reporting system
ACC	active clearance control
acclrm	accelerometer
ACE	actuator control electronics
ACIPS	airfoil and cowl ice protection system
ACM	air cycle machine
ACMF	airplane condition monitoring function
ACMS	airplane condition monitoring system
ACMP	alternating current motor pump
ACP	audio control panel
ADC	air data computer
ADF	automatic direction finder
ADIRS	air data inertial reference system
ADIRU	air data inertial reference unit
ADM	air data module
ADP	air driven pump
AES	aircraft earth station
AFDC	autopilot flight director computer
AFDS	autopilot flight director system
AGS	air/ground system
AIL	aileron
AIMS	airplane information management system
AIV	accumulator isolation valve
AMI	airline modifiable information
AMU	audio management unit
ANS	ambient noise sensor
AOA	angle of attack
AOC	air/oil cooler
AOHE	air/oil heat exchanger
APB	auxiliary power breaker
APP	approach
APU	auxiliary power unit
APUC	auxiliary power unit controller
ARINC	Aeronautical Radio, Incorporated
ASCPC	air supply and cabin pressure controllers
ASG	ARINC signal gateway
ASM	autothrottle servo motor
ASSV	alternate source selection valve
ATC	air traffic control
ATS	air turbine starter
ATT	attitude
A/T	autothrottle
AVLAN	avionics local area network
AVM	airborne vibration monitor
AWS	attendant work station
A/P	autopilot

B

BAP	bank angle protection
BITE	built-in test equipment
BMM	boarding music machine
BMV	brake metering valve
BPCU	bus power control unit
BSCU	brake system control unit
BSU	beam steering unit
BSU	bypass switch unit
BTB	bus tie breaker
BTMU	brake temperature monitor unit
BU	back up

C

CACP	cabin area control panel
CAH	cabin attendant handset
CAPT	captain
CCB	converter circuit breaker
CCD	cursor control device
CCR	credit card reader
CDG	configuration database generator
CDU	control display unit
CFS	cabin file server
CHG	charge
CHIS	center hydraulic isolation system
CI	cabin interphone
CLB	climb
CMCF	central maintenance computing function
CMCS	central maintenance computing system
CMD	command Comm communication
COMP	compressor
CON	continuous
CPC	cabin pressure controller
CPM	core processor module

Abbreviations and Acronyms

cprsr	compressor
CPS	cabin pressure sensor
CRT	cathode ray tube
CSC	cargo system controller
CSCP	cabin system control panel
CSDS	cargo smoke detection system
CSS	cabin services system
CSMU	cabin system management unit
CTAI	cowl thermal anti-icing
CTC	cabin temperature controller
CTU	cabin telecommunications unit

D

dc	direct current
DCGF	data conversion gateway function
DCMF	data communication management function
DCMS	data communication management system
DCV	directional control valve
ded	dedicated
DFDAF	digital flight data acquisition function
DFDR	digital flight data recorder
DH	decision height disch discharge
DLGF	data load gateway function
DLODS	duct leak and overheat detection
DLS	data load system
DME	distance measuring equipment
DMM	data memory module
DMS	debris monitoring sensor
DSF	display system function
DSP	display select panel
DU	display unit

E

EAI	engine anti-ice
ECS	environmental control system
ECSL	left environmental control system card
ECSMC	ECS miscellaneous card
ECSR	right environmental control system card
EDI	engine data interface
EDIF	engine data interface function
EDIU	engine data interface unit
EDP	engine driven pump
EEC	electronic engine control (PW, GE)
EEC	electronic engine controller (RR)
EEU	ELMS electronics unit
EFIS	electronic flight instrument system
EFIS CP	EFIS control panel
EGT	exhaust gas temperature
EICAS	engine indication and crew alerting system
ELMS	electrical load management system
EMC	entertainment multiplexer controller
EP	external power
EPC	external power contactor
EPCS	electronic propulsion control system
EPR	engine pressure ratio
ERP	eye reference point
ERU	engine relay unit
ETOPS	extended range operation with two-engine airplanes

F

FADEC	full authority digital electronic control
FBW	fly-by-wire
FCDC	flight controls dc
FDAF	flight data acquisition function
FDH	flight deck handset
FDR	flight data recorder
FDRS	flight data recorder system
FLCH	flight level change
FLPRN	flaperon
flt ctrl	flight control
flt inst	flight instrument
FMCF	flight management computing function
FMCS	flight management computing system
FMU	fuel metering unit
F/O	first officer
F/O	fuel/oil (cooler)
FOC	fuel/oil cooler
FPA	flight path angle
FPV	flight path vector
FQIS	fuel quantity indicating system

FQPU	fuel quantity processor unit
FREQ	frequency
FSEU	flap slat electronics unit
F/D	flight director

G

GBST	ground based software tool
GCB	generator circuit breaker
GCU	generator control unit
GES	ground earth station
GG	graphics generator
H	ground handling
GND	ground
GPS	global positioning system
GPSSU	global positioning system sensor unit
GPWC	ground proximity warning computer
GPWS	ground proximity warning system

H

HDG	heading
HIRF	high intensity radiated field
HLCS	high lift control system
HF	high frequency
HP	high pressure
HPA	high power amplifier
HPC	high pressure compressor
HPSOV	high pressure shutoff valve
HPT	high pressure turbine
HYDIM	hydraulic interface module
HX	heat exchanger

I

IC	intercabinet
IDG	integrated drive generator
IDS	ice detection system
IFE	in-flight entertainment
IGV	inlet guide vane
IGW	increased gross weight
ILS	instrument landing system
ind	indicator
INPH	interphone
IOM	input/output module
IP	intermediate pressure
IPC	intermediate pressure compressor
IPT	intermediate pressure turbine
IRP	integrated refuel panel
IRS	inertial reference system
IRU	inertial reference unit
ISLN	isolation
ISO	isolation IV isolation valve
IVD	interactive video downloader

J

K

KB	keyboard
kVA	kilovolt-ampere

L

LCD	liquid crystal display
LIB	left inboard
LNA	low noise amplifier
LOB	left outboard
LOC	localizer
LPC	low pressure compressor
LPT	low pressure turbine
LRM	line replaceable module
LRU	line replaceable unit

M

MAT	maintenance access terminal
MCP	mode control panel
MEC	main equipment center
MES	main engine start
MFD	multi-function display
MGSCU	main gear steering control unit
MLW	maximum landing weight
MMR	multi-mode receiver

N

NAVAID	navigational aid
ND	navigation display

O

OAT	outside air temperature
OEU	overhead electronics units
OPAS	overhead panel ARINC 629 system

Abbreviations and Acronyms

OPBC	overhead panel bus controller
OVRD	override
OPR	once per revolution
OPU	overspeed protection unit
oxy	oxygen

P

PA	passenger address
PA/CI	passenger address/ cabin interphone
PC	personal computer
PCU	passenger control unit
PCU	power control unit

U

ULD	unit load device
UTC	universal time (coordinated)

V

VAU	voltage averaging unit
VBV	variable bypass valve
VEP	video entertainment player
VHF	very high frequency
VIGV	variable integral guide vane
VLV	valve
VOR	VHF omnidirectional ranging
VOR/MB	VOR/ marker beacon
VOS	velocity of sound
V/S	vertical speed
VSCF	variable speed constant frequency
VSV	variable stator vane
VTO	volumetric top-off

W

WAI	wing anti-ice
WES	warning electronic system
WEU	warning electronic unit
WHCU	window heat control unit
WOW	weight on wheels
WPT	waypoint
WTAI	wing thermal anti-icing
WXR	weather radar

X

xdcr	transducer
xfr	transfer
xmt	transmit
xmtr	transmitter

Y

Z

ZMU	zone management unit